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# MINERAL WATERS OF THE UNITED STATES.

I. CLASSIFICATION AND METHODS OF ANALYSIS.
II. COMMERCIAL WATERS.
III. SARATOGA WATERS SAMPLED AT SOURCE.

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# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
*Washington, D. C., August 12, 1905.*

Sir: I have the honor to transmit for your inspection and approval a manuscript containing the results of an investigation conducted in the Insecticide and Agricultural Water Laboratory (now the Miscellaneous Laboratory) of this Bureau on the mineral waters offered for sale to the people of the United States. The object of this investigation was to determine the adulteration of these beverages by showing in what degree they conform to the claims which are made respecting their composition. The information afforded by these data is of great value to the public in general and to physicians in particular. The data contained in this report should not under any circumstances be used for any advertising or commercial purposes. I recommend that this report be published as Bulletin No. 91 of the Bureau of Chemistry.

Respectfully,

W. D. Bigelow, *Acting Chief.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# MINERAL WATERS OF THE UNITED STATES.

## INTRODUCTION.

In this study of the chemical composition of American mineral waters an attempt has been made to obtain all the most prominent spring waters as they are sold on the market and to compare the composition of such samples with the composition as advertised by the owners of the springs. To do this, agents of the Department visited all of the large mineral-water depots in both Washington, D. C., and Baltimore, Md., and purchased 2 to 5 gallon samples of the various waters in the original bottles. These samples were shipped to the laboratory, where all the waters of one kind were mixed in one large bottle, and subjected to analysis without delay. In every case where it was possible the advertising matter relating to individual samples was obtained and the analysis as given compared with the analysis as obtained at this laboratory. Where advertised analyses could not be found, the results obtained at this laboratory were compared with the results given in Crook's Mineral Waters of the United States, since most of the analyses in that volume are the same as those advertised by spring owners. Because of different methods of calculating the results of water analyses by different chemists it was necessary to compute all salts to their ions and make the comparisons on this basis.

It will be found in the following pages that the composition of waters as determined by the authors is often different from the composition as given in the advertising matter. This does not necessarily mean that there has been any attempt at fraud on the part of the owner of the spring. Sometimes the difference between the analyses may be small and immaterial, falling within the limits of error of analyses by different analysts and the natural change in the composition of the water from time to time. Sometimes the difference in analyses may be due to the fact that the advertised analysis was made years ago and that since that time the composition of the water has gradually but steadily changed. On the other hand, these differences may sometimes be due to poor analytical work on the part of the commercial chemist, sometimes to fraud on the part of the retail dealer, and sometimes even to fraud on the part of the spring owner.

The authors are now making a further study of all well-known spring waters from their source, and the second part of this report sets

forth the results already obtained on Saratoga waters so sampled. When this investigation is completed a comparison of the results with those obtained on commercial samples and with the advertised analyses will often indicate with whom the fault of falsely labeling waters lies. Until this work is completed, the following results are given, not on the assumption that they represent the true composition of the spring as it comes from the earth, but on the assumption that they at least represent the composition of the water as it is consumed by the public.

## I. CLASSIFICATION AND METHODS OF ANALYSIS.

### VARIOUS CLASSIFICATIONS OF MINERAL WATERS.

One of the first requisites in making an extended study of mineral waters is a good classification, that similar waters may be brought under a common head. Various schemes of classification have been used. Thus we have the German, the French, the English, Walton's American classification, etc. The two best schemes of classification yet arranged are, in the opinion of the writers, those published by A. C. Peale[a] and by J. K. Crook,[b] the former being somewhat the better. These classifications are as follows:

PEALE'S CLASSIFICATION

- Thermal or nonthermal.
  - I. Alkaline.
  - II. Alkaline-saline.
    - Sulphated.
    - Muriated.
    - Borated.
  - III. Saline.
    - Sulphated.
    - Muriated.
    - Borated.
  - IV. Acid.
    - Sulphated.
    - Muriated.
    - Silicious.
      - Sulphated.
      - Muriated.
- Sodic.
- Lithic.
- Potassic.
- Calcic.
- Magnesic.
- Chalybeate.
- Aluminous.

Nongaseous.
Carbonated.
Sulphureted.
Azotized.
Carbureted.
Oxygenated.

CROOK'S CLASSIFICATION.

- Thermal or nonthermal.
  - I. Alkaline.
    - Sulphated.
    - Muriated.
  - II. Alkaline-saline.
    - Sulphated.
    - Muriated.
  - III. Saline.
    - Sulphated.
    - Muriated.
  - IV. Chalybeate.
    - Alkaline.
    - Sulphated.
    - Muriated.
  - V. Neutral or indifferent.
- Sodic.
- Lithic.
- Potassic.
- Magnesic.
- Calcic.
- Iodic.
- Bromic.
- Arsenical.
- Silicious.
- Manganic.
- Acid.
- Aluminous.

Nongaseous.
Carbonated.
Sulphureted.

[a] A System of Physiologic Therapeutics, edited by S. S. Cohen, vol. 9, p. 302.
[b] Mineral Waters of the United States and Their Therapeutic Uses, p. 30.

While the authors believe that Peale's classification is much better than other classifications heretofore proposed, there are certain points where it is either weak or fails. They are of the opinion that to classify on a strictly chemical basis and in line with modern research the following changes should be made:

(1) The four classes of thermal and nonthermal waters, i. e., alkaline, alkaline-saline, saline, and acid, should be defined, not on the basis of combinations of the ions present, as is done by Peale, but on the basis of the ions themselves, since no chemical methods are known by which we can determine the relative amounts of the acid and basic ions entering into combination with each other to form salts.

(2) The alkaline group should contain not only the carbonated, but also the borated and silicated waters, since waters are known which owe their alkalinity, at least in part, to alkaline borates or silicates.

(3) The alkaline-saline and saline groups should be divided into sulphated, muriated, and nitrated waters, since the authors have found one water at least which makes the introduction of a nitrated group an absolute necessity.

(4) The acid group should be divided into sulphated and muriated only and should not contain the silicious. Any of the four groups may be silicious, so this term should refer to all groups rather than to the acid group alone.

For the above reasons the authors have adopted the following method of classification, which will hereafter be followed by them in all publications relating to American mineral waters:

AUTHORS' CLASSIFICATION.

| Group. | Class. | Subclass. | | |
|---|---|---|---|---|
| Thermal. Nonthermal. | I. Alkaline. | Carbonated or bicarbonated. | Sodic. | Nongaseous. Carbondioxated. Sulphureted. Azotized. Carbureted. Oxygenated. |
| | | | Lithic. | |
| | | Borated. | Potassic. | |
| | | Silicated. | Calcic. | |
| | II. Alkaline-saline. | Sulphated. | Magnesic. | |
| | | Muriated. | Ferruginous. | |
| | | Nitrated. | Aluminic. | |
| | III. Saline. | Sulphated. | Arsenic. | |
| | | Muriated. | Bromic. | |
| | | Nitrated. | Iodic. | |
| | IV. Acid. | Sulphated. | Silicious. | |
| | | Muriated. | Boric. | |

*Thermal waters* may be defined as those which issue from the earth at a markedly higher temperature than the surrounding atmosphere throughout the whole year, and nonthermal waters as those which issue from the ground at approximately the same temperature or less than the temperature of the surrounding atmosphere throughout the whole year. By reason of the fact, however, that such a classification

as the foregoing would produce a sliding scale, and would classify as thermal a water which in a warmer climate would be nonthermal, it has been thought best to adopt the scheme of Dr. A. C. Peale, and classify all waters above 70° F. as thermal and all below as nonthermal. Waters between 70° F. and 98.6° F. would, according to this classification, be considered as tepid or warm, while waters above 98.6° F. would be considered as hot.

*Alkaline waters* are (1) those which have an alkaline reaction[a] and contain carbonic or bicarbonic acid ions in predominating quantities; (2) those which have an alkaline reaction and contain boric or silicic acid ions in predominating quantities, where it can be proved that the alkalinity is largely due to the presence of borates or silicates. The first class of alkaline waters is well known and is given in Peale's classification as constituting the whole class of alkaline waters. The second class of alkaline waters includes those which are more alkaline than can be accounted for by the carbonates or bicarbonates present, and contains predominating quantities of silicates or borates, which evidently cause this excess of alkalinity.

*Saline waters* are those which have an alkaline or neutral reaction and contain sulphuric, muriatic, or nitric acid ions in predominating quantities.

*Alkaline-saline waters* are between alkaline and saline. They embrace those which have an alkaline reaction and contain (1) sulphuric, muriatic, or nitric acid ions along with carbonic or bicarbonic acid ions, both classes being present as predominating constituents or those which have an alkaline reaction and (2) contain sulphuric, muriatic, or nitric acid ions along with boric or silicic acid ions, both classes being present as predominating constituents, where it can be proved that the alkalinity is largely due to the presence of borates or silicates.

*Acid waters* are those which have an acid reaction, and contain either sulphuric or muriatic acid ions in predominating quantities.

### METHOD OF NAMING MINERAL WATERS.

If any basic element is prominent in the mineral water this fact may be indicated by prefixing the name of the base to the regular class name; as sodic, lithic, calcic, etc.; carbonated alkaline, borated alkaline, silicated alkaline, sulphated alkaline-saline, etc.

If any basic or acid ion is prominent therapeutically but not chemically, this fact may be indicated by affixing the name of the basic or acid ion to the regular name; as carbonated alkaline (arsenic, bromic, iodic, etc.).

[a] Where acid and alkaline reactions are mentioned in these definitions, methyl orange is supposed to be used as indicator.

The gaseous constituents of all the foregoing classes of waters may be designated by the following terms:

| | |
|---|---|
| Nongaseous | Containing no gas. |
| Carbondioxated[a] | Containing carbon dioxid gas. |
| Sulphureted | Containing hydrogen sulphid gas. |
| Azotized | Containing nitrogen gas. |
| Carbureted | Containing methane gas. |
| Oxygenated | Containing oxygen gas. |

The following scheme enables one to name any mineral water according to the authors' classification:

| | | | | | |
|---|---|---|---|---|---|
| Thermal or nonthermal. | Sodic. | Carbonated or bicarbonated. | Alkaline. | Arsenic. | Nongaseous. |
| | Lithic. | Borated. | | Bromic. | Carbondioxated. |
| | Potassic. | Silicated. | | Iodic. | Sulphureted. |
| | Calcic. | Sulphated. | Alkaline-saline. | Silicious. | Carbureted. |
| | Magnesic. | Muriated. | | Boric. | Oxygenated. |
| | Ferruginous. | Nitrated. | | Lithic. | |
| | Aluminic. | Sulphated. | Saline. | Ferruginous. | |
| | | Muriated. | | Etc. | |
| | | Nitrated. | | | |
| | | Sulphated. | Acid. | | |
| | | Muriated. | | | |

A few examples may serve to render this system of nomenclature more intelligible. Massanetta water (No. 689, p. 34) would be classed as a nonthermal, calcic, bicarbonated, alkaline water; the Hot Borate Springs of California (Crook's Mineral Waters of the United States, p. 147) would be classed as a thermal, sodic and ammonic, borated and bicarbonated, alkaline (iodic) water; Hathorn Saratoga water (No. 901, p. 45) as a nonthermal, sodic, muriated, alkaline-saline (lithic, bromic, iodic) carbondioxated water; Cherrydale water (No. 1013, p. 54) as a nonthermal, sodic, and calcic, nitrated and muriated saline water; and Rockbridge alum water (No. 1223, p. 72) as a nonthermal, aluminic, sulphated, acid (ferruginous) water.

It is believed by the authors that if such a nomenclature as the above were followed the general public would be able to obtain more information from the name alone than from the inspection of an analysis. It is apparent that much work would be saved for the physician, who could soon reduce the waters to be considered in any given case to a comparatively small number simply by the use of a well-arranged index instead of being compelled to study hundreds of analyses. The group, class, and subclass having been determined, it would be a comparatively easy matter to study the individual analyses.

[a] This word is introduced so as to distinguish between free carbon dioxid and carbon dioxid in combination.

MEDICINAL VALUE OF VARIOUS CLASSES OF MINERAL WATERS.

The physiological action and therapeutic applications of the various classes of mineral waters here given do not represent the results of experiments carried on in the Bureau of Chemistry, but are gathered from works which are considered authoritative on the subject.[a]

*Carbonated or bicarbonated alkaline waters.*—This is one of the most important groups of mineral waters. As a class these waters are used to stimulate the secretions of the digestive tract, neutralize superacidity of the stomach, increase metabolism, dissolve uric acid, increase the flow of urine, correct acidity of the urine, and dissolve uric acid deposits. They are therefore of value in catarrhal conditions of the mucous membranes, rheumatism, gout, diabetes, etc.

*Sodic carbonated and bicarbonated alkaline waters.*—Sodium carbonate or bicarbonate appears as a normal constituent of the blood, lymph, and nearly all secretions of the mucous membrane. Where conditions arise that cause any of these fluids to become acid, this class of waters is of great value in counteracting the effect. The sodic carbonated waters increase metabolism, dissolve uric acid, and allay irritation of the mucous membrane of the urinary tract. They have therefore been used with excellent results in treating acid dyspepsia, rheumatism, gout, and diabetes. Such waters are also of value in breaking up and eliminating uric acid deposits and uric acid sand and gravel.

*Potassic carbonated and bicarbonated alkaline waters* have very much the same action as the sodic carbonated, except that they are perhaps better for increasing the solubility and elimination of uric acid. The chief use of such waters as these is in the treatment of stone in the bladder.

*Lithic carbonated and bicarbonated alkaline waters.*—While lithium seldom or never occurs in waters in large enough quantities to be a predominating basic constituent, still it does often appear in sufficient quantities to have a decided therapeutic action. These compounds are active diuretics and form a very soluble urate which is easily eliminated from the system. Waters of the above class therefore find their greatest application in the treatment of rheumatism, rheumatic tendencies, and gout. In cases of gravel and calculi they are also valuable disintegrating agents.

*Magnesic carbonated and bicarbonated alkaline waters.*—Such waters as these act as mild laxatives and are perhaps the best of all the carbonated alkaline waters in correcting an acid condition of the stomach and curing sick headaches caused by constipation. They favor the solution of uric acid, are valuable agents in breaking up

[a] Among these are Crook's Mineral Waters of the United States and Canada, Schweitzer's Mineral Waters of Missouri, and Cohen's System of Physiologic Therapeutics.

deposits in the bladder, and are much used in catarrhal conditions of the mucous membrane of the urinary organs.

*Calcic carbonated and bicarbonated alkaline waters.*—This class of waters is quite different in its effect from the carbonated waters previously mentioned. While the foregoing waters are evacuant and promote secretions, this class of waters constipates and decreases the secretions. Very obstinate cases of chronic diarrhea have been cured by a sojourn at a spring rich in calcium bicarbonate. Uric acid gravel and calculi are also disintegrated and eliminated by the free use of the above waters.

*Ferruginous bicarbonated alkaline waters.*—These waters increase the amount of hæmoglobin and in connection therewith increase the temperature, pulse, and weight. They also increase the appetite and reduce intestinal activity. Such waters give excellent results when used as a tonic. They find their principal application in anæmia and in general debility brought about by sexual diseases. Too long use of waters rich in iron results in constipation and derangement of the digestion.

*Borated alkaline waters.*—There are comparatively few springs of this description which have been used to any extent. Their therapeutic application, therefore, is somewhat obscure. It may be said, in general, that such waters act as anti acids. They promote the menstrual flow, and so may be used in catamenial irregularities. Applied locally to catarrhal mucous membranes, they are of value.

*Muriated alkaline-saline waters.*—These waters are especially valuable in the treatment of catarrhal conditions of the mucous membrane of the stomach, intestines, and biliary passages, and urinary tract. They increase the flow of urine and the excretion of uric acid. The stronger ones are often used as a gargle.

*Sulphated alkaline-saline waters.*—These waters, like the preceding class, are valuable in the treatment of catarrhal conditions of the mucous membrane. They also act as diuretics. In large quantities they act as purgatives by increasing the peristaltic movement and liquefying the intestinal contents. Such waters as these are especially indicated in obesity.

*Muriated saline waters.*—As a whole these waters stimulate the secretion of the stomach, increase digestion, favor a more complete absorption of foods, and act as diuretics.

*Sodic muriated saline waters.*—Where these waters are very heavily charged with sodium chlorid they are often used for baths, to increase the action of the skin, and by absorption act as a tonic. Such waters when taken internally are usually diluted. They increase the flow of gastric juice, improve the appetite, increase the flow of urine, and the urea in the same. They also prevent putrefactive changes in the intestines.

*Potassic muriated saline waters.*—The authors do not know of any waters which belong to the muriated saline group and yet contain potassium as a predominating constituent. However, potassium is sometimes present in these waters in considerable quantities. Its therapeutic action is very much like that of the sodium salt.

*Lithic muriated saline waters.*—Such waters as these would have the usual action of the muriated saline class, with an intensified diuretic effect, due to the lithium.

*Calcic muriated saline waters.*—These waters usually have sodium as the predominating basic constituent, along with notable amounts of calcium and sometimes magnesium. In general debility these waters act as a tonic. They increase the flow of urine, sweat, and bile, and are used in the treatment of scrofulous diseases and eczema.

*Sulphated saline waters.*—As a class, these waters are laxative or purgative, according to the quantity taken, and should generally only be used in moderate amounts. They are especially indicated where long-continued stimulation of the intestinal activity is desired without stimulation of the vascular system.

*Sodic and magnesic sulphated saline waters.*—In small doses these waters act as laxatives and in large doses as purgatives. They increase the flow of the intestinal fluids and of the urine, the latter being accompanied by an increased elimination of urea. Such waters as these are of great service in eliminating syphilitic, scrofulous, and malarial poisons from the system and in throwing off mercury and other metallic poisons. Persons suffering from obesity, dropsy, derangement of the liver, and Bright's disease are perhaps the most benefited by this class of waters.

*Potassic sulphated saline waters.*—While potassium may be present in large enough quantities in the sulphated saline waters to deserve mention, the authors do not know of any waters in which it is a predominating basic constituent. In so far as it is present, however, it has very much the same effect as the two salts mentioned above.

*Calcic sulphated saline waters.*—This class of waters forms what is known as the permanently hard group. They have no well-known therapeutic action.

*Ferruginous sulphated saline waters and aluminic sulphated saline waters.*—Iron and aluminum usually occur together when either is present as a predominating metallic constituent in sulphated saline waters. Since waters containing large quantities of iron and aluminum along with sulphuric acid ions are practically always acid, it is best to consider them under the sulphated acid group.

*Nitrated saline waters.*—The authors have only found one water which belongs to this class, and are undecided, on account of not being able to examine the surroundings of the spring, whether the nitrates

are due to organic nitrogenous matter which is in active state of decomposition or to nitrogenous matter which has been oxidized in times long past and is therefore no longer injurious. In either case, however (especially the latter), the existence of one water containing predominating quantities of nitrates necessitates a classification to cover this group of waters. The medicinal action of these waters has not been determined.

*Acid waters.*—This group of waters is principally composed of the ferruginous-aluminic sulphated class, although there are a few acid springs which contain comparatively little iron and aluminum, but quite large amounts of calcium, sodium, or magnesium. These waters are used in relaxed conditions of the mucous membrane, especially when characterized by diarrhea or dysentery. They are also used in the treatment of exhausting night sweats and impoverished conditions of the body brought about by intemperance or specific diseases. Locally they are used in treating inflamed or relaxed conditions of the mucous membrane such as are found in conjunctivitis, chronic vaginitis, etc. The ferruginous waters of this group have the usual effect of all iron waters, such as has already been described under ferruginous carbonated alkaline waters. When a water is desired for its tonic effect it is best to give it in the ferruginous carbonated form, since it is more easily absorbed and assimilated.

*Iodic and bromic waters.*—Since iodin and bromin usually accompany each other in mineral waters, they should be considered together. Waters of this class act as alteratives. They stimulate the lymphatic system to greater activity and promote absorption in all the tissues. Their employment is therefore indicated in the treatment of scrofula, syphilis, goiter, chronic exudations, etc. They also favor the elimination of mercury and other metallic poisons. The bromic waters also act as sedatives.

*Arsenic waters.*—These waters act as an alterative, increase the appetite and digestion, and improve the whole nutrition of the body. They do this not only by increasing the secretion of the gastro-intestinal membrane, but also by checking katabolism. Such waters as these are especially valuable in the treatment of anæmia and a number of skin diseases. They are also indicated in the treatment of chronic malarial poisoning, neuralgia of anæmic origin, scrofulosis, etc.

*Silicious waters.*—The medicinal value of these waters has not been thoroughly investigated, although one or two investigations have been made which seem to show that they would be of value in the treatment of cancer. It has been stated that silica taken internally has caused albumin and sugar to disappear from the urine.

*Azotized and oxygenated waters.*—Both nitrogen and oxygen are present in all waters that have come in contact with the air. On

account of the limited solubility of both they can not occur in waters in very large quantities. Neither of them as they occur in waters has any medicinal value.

*Carbondioxated waters.*—These waters contain free carbon dioxid as distinguished from the carbonated or bicarbonated waters which contain carbon dioxid in combination. Usually the heavily carbondioxated waters are also bicarbonated, but this is not necessarily true. Free carbon dioxid is present in practically all natural waters to some extent, but in some waters, notably the Saratoga, it is present in very large quantities. Such waters are extremely palatable and large quantities can be drunk without causing a "full feeling." These waters tend to increase the flow of saliva and intestinal fluids, also to increase the peristaltic movements of the stomach, and therefore increase digestion. They also tend to increase the flow of urine. Obstinate cases of nausea are often relieved by the use of this class of waters.

*Carbureted waters.*—These waters sometimes occur in coal and natural-gas regions. They are not known to have any medicinal value, but are usually considered unfit for drinking purposes.

*Sulphureted waters.*—These waters increase the action of the skin, intestines, and kidneys. They also possess a decided alterative effect. They have been used in the treatment of syphilis, chronic metallic poisoning, rheumatism, and gout. They have also given excellent results in many skin diseases, hyperæmia of the liver, and in catarrhal conditions of the pharynx, larynx, and bronchi.

## METHODS OF ANALYSIS.

### GENERAL METHOD OF REPORTING RESULTS.

The following determinations were made on all of the waters examined: Lithium, potassium, calcium, manganese, iodin, chlorin, sodium, magnesium, iron and aluminum, arsenic, bromin, boric acid, nitric acid, sulphuric acid, carbonic acid, phosphoric acid, nitrous acid, silicic acid, bicarbonic acid, free ammonia, albuminoid ammonia, and oxygen consuming capacity. Besides these determinations, barium, strontium, and hydrogen sulphid were determined in cases where there was reason to suspect their presence.

In reporting the results of analysis the bases and acids are given in parts per million of the positive and negative ions, except in the case of silica, which in the present state of our knowledge we can usually only report as such, not going into the question of how much is present as the silicic acid ion and how much as free silica. Iron and aluminum when present in unimportant quantities are reported together, and in calculations involving this figure the whole is considered as iron and given the atomic weight of 55.9. When iron and aluminum are present in larger quantities a separation is made and each element reported separately.

The authors have, much against their inclination, thought it best to combine the acids and bases in a hypothetical combination to form salts, since the time does not yet seem ripe to abandon this antiquated method of reporting the results of water analyses. That such a combination has no basis in fact is doubtless true, since we have every reason to believe that in cases where various acids and basic ions are present in solution no base unites with any one acid to the exclusion of all other acids, or vice versa, but all possible combinations of the various basic and acid ions in solution are formed to some extent. For example, suppose we have calcium bicarbonate in solution. It partly dissociates into its ions as follows:

$$Ca(HCO_3)_2 \rightleftarrows \overset{++}{Ca} + 2(H\overset{--}{CO_3})$$

Again, if magnesium sulphate is in solution it partly dissociates, as follows:

$$MgSO_4 \rightleftarrows \overset{++}{Mg} + \overset{--}{SO_4}$$

If these two solutions are mixed, part of the calcium and sulphuric acid will unite to form calcium sulphate, as follows:

$$\overset{++}{Ca} + \overset{--}{SO_4} \rightleftarrows CaSO_4$$

and part of the magnesium and bicarbonic acid ions will unite to form magnesium bicarbonate, as follows:

$$\overset{++}{Mg} + 2(H\overset{--}{CO_3}) \rightleftarrows Mg(HCO_3)_2$$

so that, in addition to calcium bicarbonate, magnesium sulphate, calcium, magnesium, bicarbonic acid, and sulphuric acid ions present at first, there are also calcium sulphate and magnesium bicarbonate in solution.

In calculating the hypothetical combinations of these acid and basic ions, sodium is joined to nitrous and nitric acid, potassium to iodin and bromin, calcium to phosphoric acid, and sodium to metaboric acid. The residual basic ions are then assigned in the following order—ammonium, lithium, potassium, sodium, magnesium, calcium, manganese, iron, and aluminum—to the residual acid ions in the following order—chlorin, sulphuric acid ion, carbonic acid ion, and bicarbonic acid ion. In case the bicarbonic acid ion is not present in sufficient quantities to join with all the calcium, the residual calcium is joined to silica to form calcium silicate, and manganese, iron, and aluminum are calculated to the oxids $Mn_3O_4$, $Fe_2O_3$, and $Al_2O_3$, respectively.

## DETAILED METHODS OF ANALYSIS.

The following methods are, to a large extent, the same as those published about three years ago in a Senate document[a] on the composition of the hot springs of Arkansas, this investigation having

[a] Haywood, Report of an analysis of the waters of the hot springs on the Hot Springs Reservation, Hot Springs, Garland County, Ark. Document No. 282, 1902.

been conducted at the request of the Interior Department. As they probably did not reach a large number of chemists or physicians in that form their republication in this connection seems advisable.

### HYDROGEN SULPHID.

This determination was made by a method outlined in Sutton's Volumetric Analysis, and is as follows:

About 0.5 to 2 cc of tenth normal iodin is measured into a 500 cc flask and the water under examination run in till the color of the iodin disappears. Five cubic centimeters of starch water is added and tenth normal iodin run in till the blue color appears. The flask is then filled to the mark with distilled water. The amount of water actually titrated is found by subtracting the sum of iodin, starch solution, and distilled water from 500 cc. As an excess of iodin solution is required to produce the blue color, a correction is applied by making 5 cc of starch solution up to 500 cc with distilled water and adding tenth normal iodin until the color of the solution is just as blue as that in the actual determination. This figure subtracted from the first figure gives the number of cubic centimeters of tenth normal iodin used by the hydrogen sulphid.

### CARBON DIOXID (IN EXCESS OF THAT NECESSARY TO FORM NORMAL CARBONATES).

The determination of the carbon dioxid existing in water in excess of that present as normal carbonates was made by a method given in Sutton's Volumetric Analysis and designed by Pettenkofer. One hundred cubic centimeters of the water are treated in a flask with 3 cc of a saturated solution of calcium chlorid, 2 cc of a saturated solution of ammonium chlorid, and 45 cc of a saturated solution of calcium hydroxid whose strength has previously been determined in terms of tenth normal hydrochloric acid, using lacmoid as indicator. The flask is stoppered, the solution well mixed, and the whole set aside for twelve hours to allow the calcium carbonate to settle. At the end of this time 50 cc of the clear solution are drawn off in a pipette and titrated with tenth normal hydrochloric acid, using lacmoid as indicator. This result is multiplied by three and subtracted from the amount of tenth normal hydrochloric acid necessary to neutralize 45 cc of the calcium hydroxid solution, thus giving the amount of calcium hydroxid solution acted upon by the carbon dioxid in terms of tenth normal acid. Multiplying the number of cubic centimeters so found by 0.0022, the weight of carbon dioxid in 100 cc above that necessary to form normal carbonates is found. Dividing the weight so found by the weight of 1 cc of carbon dioxid at 0° C. and 760 mm pressure and multiplying the result by 10, the number of cubic centimeters of carbon dioxid in a liter in excess of that necessary to form normal carbonates is obtained. The figure is then corrected to correspond to 1,000 grams of the water.

CARBON DIOXID (GIVEN OFF FROM THE BICARBONATES WHEN THE WATER IS EVAPORATED TO DRYNESS).

In making this determination the method of Cameron[a] for the estimation of carbonates and bicarbonates in aqueous solution was used. By this method the amount of bicarbonic acid ions ($HCO_3$) present was determined, and from this an estimation made of the amount of bicarbonic acid that would remain as normal carbonate and the amount that would be given off as carbon dioxid. The method is as follows:

To 100 grams of the water add a few drops of phenolphthalein. In case there are alkali carbonates present the usual red color will be evident. The solution is now titrated with a twentieth normal solution of acid potassium sulphate ($HKSO_4$), adding a drop every two or three seconds, until the red color has completely disappeared. The reading on the burette is recorded, and to the clear solution one drop of methyl orange is added. A pure yellow color results. The titration is continued with $HKSO_4$, without refilling the burette until the change to a very slightly darker and reddish color is noted. The change is faint and practice is required to detect it. The reading at this point is also recorded.

The first reading recorded gives the amount of alkali carbonates present, and must be multiplied by the factor 0.002979 for the results in grams of $CO_3$ ions.

For the number of grams of bicarbonic acid ($HCO_3$) ions present the first recorded reading is multiplied by two and the result subtracted from the second reading, and this remainder is multiplied by the factor 0.003028.

Having now obtained the weight of $HCO_3$ in 1,000 grams of water, calculate the weight of $CO_2$ given off when a like amount is evaporated to dryness, and dividing this result by the weight of 1 cc of carbon dioxid at 0° C. and 760 mm pressure, the number of cubic centimeters of carbon dioxid given off from the bicarbonates is obtained. Subtract the number of cubic centimeters of carbon dioxid given off from the bicarbonates from the number of cubic centimeters of carbon dioxid in excess of that necessary to form normal carbonates, and the result is the number of cubic centimeters existing in solution in a free state.

BICARBONIC ACID.

The amount of this substance present in the spring was estimated during the process of determining the amount of carbon dioxid given off from bicarbonates in the preceding paragraph.

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[a] Report 64, U. S. Dept. Agr., Field operations of the Division of Soils, 1899; Amer. Chem. J., 1900, **23**:471.

NITRIC ACID.

For the determination of nitric and nitrous acid, free and albuminoid ammonia, and oxygen-consuming capacity, the methods as given in Mason's Examination of Water were followed in all their principal details. They are as follows:

In determining nitric acid 100 grams of the spring water are treated with 2 drops of a saturated solution of sodium carbonate and evaporated to dryness on the water bath. The residue is treated with 2 cc of phenol-sulphonic acid (made by mixing 148 cc of pure sulphuric acid, 12 cc of water, and 24 grams of phenol), a little water added, and then an excess of ammonia. The solution is transferred to a 100 cc Nessler jar, the volume made up to 100 cc with distilled water, and the depth of the yellow color compared with that produced by treating different amounts of standard potassium nitrate (containing 0.01 mg of nitrogen as nitrate in each cubic centimeter) in the same manner. Where more than 6 parts per million of chlorin are present in a sample of spring water, an amount of chlorin (in the form of sodium chlorid) corresponding to the amount of chlorids present in the sample under examination is added to the standards before evaporation.

NITROUS ACID.

For this determination 100 grams of the water are placed in a 100 cc Nessler jar and treated with one or two drops of concentrated hydrochloric acid. One cubic centimeter of sulphanilic acid (containing 1 gram in each 100 cc of water) is then added, followed by 1 cc of a solution of naphthylamin hydrochlorid (obtained by boiling 0.5 gram of the salt with 100 cc of water for ten minutes at constant volume), and the whole well mixed. The Nessler jar is then set aside for half an hour, along with several other Nessler jars containing known amounts of a standard nitrite solution (containing 0.0001 mg of nitrogen as nitrite in each cubic centimeter), made up to 100 cc with nitrite-free water, and treated with hydrochloric acid, sulphanilic acid, and naphthylamin hydrochlorid in the manner just described. By comparing the depth of pink color in the known and unknown solutions the amount of nitrite can be determined.

FREE AMMONIA.

A large flask of about 1.5 liters' capacity is connected to an upright bulbed condenser by means of a rather large glass tube and soft, new, rubber-stoppered connections. In this is placed 5 cc of a saturated solution of sodium carbonate and 200 cc of ammonia-free water. The water is distilled off in 50 cc Nessler jars until no more ammonia is shown, when the jars are nesslerized. Five hundred grams of the water under examination are now added and the distillation in 50 cc Nessler jars continued till ammonia ceases to be given off. About four

or five jars are usually necessary. These jars are nesslerized and the depth of color compared with that in other jars containing known amounts of a standard ammonium chlorid solution (0.01 mg of $NH_3$ in each cubic centimeter), made up to 50 cc with ammonia-free water and nesslerized in the same manner.

TOTAL AMMONIA.

The same apparatus is used as that mentioned in the preceding paragraph. In it are placed 200 cc of distilled water and 50 cc of alkaline permanganate solution (prepared by dissolving 200 grams of potassium hydroxid and 8 grams of potassium permanganate in 1,250 cc of water and boiling the whole down to about 1 liter). The water is distilled off in 50 cc Nessler jars until ammonia ceases to come over. Five hundred grams of the water under examination are now added and the distillation continued until ammonia ceases to come off. Six jars are in most cases sufficient. These jars are nesslerized and compared with nesslerized jars of known strength just as in the determination of free ammonia. From the total ammonia thus found subtract the free ammonia and the result is the albuminoid ammonia in 500 cc of water.

Many precautionary details of the two above methods are not given, but can be found by consulting any good work on water analysis.

OXYGEN-CONSUMING CAPACITY.

In making this determination two solutions were prepared: (1) A standard solution of potassium permanganate containing 0.3952 gram to the liter, each cubic centimeter of which has 1 mg of oxygen available for oxidation; and (2) a standard solution of oxalic acid containing 0.7875 gram of crystallized oxalic acid to the liter. The value of the oxalic acid in terms of the permanganate is determined by boiling 10 cc of oxalic acid solution and 200 cc of distilled water with 10 cc of sulphuric acid (1 to 3) and titrating the fluid while boiling with the standard permanganate solution to the appearance of a pink color. In the actual determination 200 grams of the water in a porcelain dish are treated with 10 cc of sulphuric acid (1 to 3) and the whole brought to the boiling point. Standard permanganate is run in until the water is quite red and the boiling continued for ten minutes, adding permanganate every now and then to keep the pink color about the same. The boiling is now stopped, 10 cc of oxalic acid run in, which destroys the color, and the solution titrated with the standard permanganate to the appearance of a pink color. From the total number of cubic centimeters of permanganate used subtract the number of cubic centimeters equal to 10 cc of oxalic acid. The result gives the number of cubic centimeters of permanganate required for 200 grams of water.

### CHLORIN.

One hundred grams of the water under examination are treated with a few drops of phenolphthalein. If a red color is shown, the carbonates thus indicated are titrated to bicarbonates by the addition of twentieth normal $HKSO_4$ added at the rate of a drop every few seconds until the red color disappears.[a] A few drops of potassium chromate are now added and the chlorids titrated with a standard solution of silver nitrate. If iodids and bromids are found, a correction of this figure is made based on the amount of these constituents present.

To determine bromin, iodin, arsenic, and boric acid, large quantities of water are evaporated to dryness, after the addition of small amounts of sodium carbonate. The residue thus obtained is boiled with distilled water, transferred to a filter, and thoroughly washed with hot water. The alkaline filtrate is made to a definite volume and aliquot portions taken to determine the above constituents.

### IODIN AND BROMIN.

The qualitative tests for the presence of iodin and bromin are very much the same as those used in Fresenius. An aliquot portion from the alkaline filtrate is evaporated to dryness on the steam bath. Two or three cubic centimeters of water are added to dissolve and soften up the residue and enough absolute alcohol is added to make the percentage of alcohol about 90. This is boiled and filtered and the treatment with 90 per cent alcohol repeated once or twice. Two or three drops of sodium hydrate solution are added to the filtrate and it is evaporated to dryness. The same process of extracting with 90 per cent alcohol is repeated on the new residue and the extract filtered off from the undissolved portion. A drop of sodium hydrate is now added to the filtrate and it is evaporated to dryness. The residue is treated with a little distilled water, dilute sulphuric acid added to acid reaction, the liquid transferred to a test-tube, and a little carbon bisulphid added. Three or four drops of potassium nitrite solution are then added and the test-tube shaken. The presence of iodin is shown by a pink color in the carbon bisulphid. Chlorin water is added until the pink color due to the iodin has disappeared, and then a little more chlorin water. The presence of bromin is shown by an orange color in the carbon bisulphid.

In most cases the above qualitative examination was all that was necessary, since the iodin and bromin were usually not present, or only as traces. In case the qualitative examination showed a *very*

[a] Cameron, Amer. Chem. J., 1900, **23**: 481.

*large* amount of bromin the following method devised by Gooch and Whitfield[a] was used:

An aliquot portion of the alkaline filtrate is evaporated to dryness and extracted with 90 per cent alcohol, as in the qualitative examination just described. The alcohol extract is evaporated to dryness, acidulated with dilute sulphuric acid, mixed with a ferric sulphate solution, and distilled from a retort which is joined to a condenser, sealed by a U-tube filled with water and carbon bisulphid. If iodin is present, it colors the carbon bisulphid and is titrated with sodium thiosulphate.

After the distillation has been continued long enough to be sure that all iodin has been volatilized, crystals of potassium permanganate are added and the distillation continued as before, except that the U-tube, acting as a seal, is now filled with water and chloroform. The contents of the tube are treated with sodium hydroxid and zinc in a beaker and the chlorid and bromid solution so formed acidified with nitric acid and precipitated with silver nitrate. The precipitate is dried and weighed. It is then dissolved in potassium cyanid and the silver precipitated by electrolysis.[b] In this way data on the weight of the combined silver chlorid and bromid and the weight of silver in same is determined and the weight of the bromin calculated.

After the authors had used the above quantitative method on a number of waters the need of a shorter method became apparent, both on account of the time element involved and because of the fact that in evaporating large volumes of heavily mineralized waters the large quantities of salts other than iodids and bromids are very difficult to handle. A colorimetric method was therefore devised by the senior author (based on the usual qualitative method of examination) which was used in subsequent examinations when bromids and iodids were present in moderately small quantities. Where bromids and iodids were present in very large quantities, however, the Gooch and Whitfield method was still followed. The procedure for the colorimetric method is as follows:

An aliquot portion of the alkaline filtrate (p. 22) is evaporated to dryness and extracted with 90 per cent alcohol just as in the qualitative examination above. The residue is dissolved in a little water, acidified with sulphuric acid (1 to 5) only using about 3 or 4 drops of acid in excess, and transferred to a small flask. Four drops of 2 per cent potassium nitrite solution are now added along with about 5 cc of carbon bisulphid freshly purified by distillation. The whole is shaken up till all iodin is extracted. A filter is now moistened and the acid solution filtered off from the carbon bisulphid. The flask, filter, and contents are washed with cold distilled water and the carbon bisulphid

[a] U. S. Geological Survey, Bul. 47.

[b] Whitfield, Amer. Chem. J., 1886, 8: 421.

(containing the iodin in solution) transferred to a 12 cc Nessler[a] tube by means of about 5 cc of pure carbon bisulphid. The contents of the tube is made up to the mark and the color matched with that of other 12 cc tubes containing known amounts of iodin dissolved in carbon bisulphid. These standard tubes are prepared by taking measured quantities of a solution of known potassium iodid content, acidifying with sulphuric acid (1 to 5), adding 3 or 4 drops of potassium nitrite, and extracting with carbon bisulphid just as in the actual determination.

The filtrate from the carbon bisulphid is now used for determining bromin. To the filtrates from the iodin standards, different measured quantities of a potassium bromid solution of known strength are now added, the standards being run along with the actual determination and conducted in exactly the same way. The filtrates (both from the actual determination and from the standards) are transferred to small flasks and freshly prepared chlorin water added. Usually 2 to 8 cc of a saturated solution of chlorin is sufficient. Care must be taken not to add too much chlorin in excess of that necessary to set the bromin free, since a bromo-chlorid is apt to be formed with an excess of the reagent, thus spoiling the color reaction.

It was found also that the best results are obtained by adding approximately the same excess of chlorin to the standards as to the actual determination. This may be accomplished by adding the chlorin water 1 cc at a time and shaking between additions. After a little practice one can approximately determine when the chlorin ceases to set bromin free. After all bromin has been thus set free, 5 cc of freshly purified carbon bisulphid is added to each of the flasks and the whole well shaken. The water solution is now filtered off from the carbon bisulphid through a moistened filter, the contents of the filter washed two or three times with water and then transferred to a 12 cc Nessler tube by means of about 1 cc of carbon bisulphid. This extraction of the filtrate is repeated twice, using 3 cc of carbon bisulphid each time. The combined carbon bisulphid extracts usually amount to about 11.5 cc to 12 cc. If they do not come quite up to the 12 cc mark, enough carbon bisulphid is added to each tube to bring them to the required volume and the sample is then compared with the standards. In some cases when working with the method near its upper limit the authors found that the bromin was not quite all extracted by the amounts of carbon bisulphid recommended above. In such a case one or two extra extractions with carbon bisulphid were made, the extracts were transferred to another 12 cc tube, and the color compared with some of the low standards.

[a] This tube was made from the ordinary 10 cc Nessler tube by re-marking it at the level of 12 cc of liquid.

To test the limits of this method a solution of potassium iodid containing 0.1 mg of potassium iodid per cubic centimeter and a solution of potassium bromid containing 1 mg of potassium bromid per cubic centimeter were prepared. Measured quantities of the potassium iodid solution were first taken and the iodin set free, extracted with carbon bisulphid, and made up to 12 cc. It was found that the difference between the following standard tubes could be easily read: 0.01, 0.02, 0.04, 0.06, 0.08, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1 mg of potassium iodid. Below this limit the amount of iodin was so small as to be considered only a trace, and above this limit the solution became too dark colored for a good reading. It will be seen from this that when 1,000-gram samples of water are used waters containing between 0.01 and 1 part per million of potassium iodid can be easily read by this method; where 500-gram samples are used, waters containing between 0.02 and 2 parts per million of potassium iodid can be read, and where 200-cc samples are used waters containing between 0.05 and 5 parts per million of potassium iodid can be read. It was thought best not to take a smaller sample than 200 cc since the error in parts per million would be greatly increased. It is therefore evident that the limit of this method for potassium iodid is 0.01 to 5 parts per million, and for iodin itself 0.008 to 3.8 parts per million, according to the amount of sample used.

Working on potassium bromid in the same way it was found that the difference between the following standards could be easily read: 0.1, 0.2, 0.4, 0.6, 0.8, 1, 2, 3, 4, 5, 6, 7, 8 mg of potassium bromid. It will be seen from this that the limits for 1,000-gram samples of water were 0.1 to 8 parts of potassium bromid per million; for 500-gram samples, 0.2 to 16 parts per million of potassium bromid; and for 200-gram samples, 0.5 to 40 parts per million. This would make the total limits of the method, never using less than 200 grams or more than 1,000 grams of water, 0.1 to 40 parts per million for potassium bromid, or 0.07 to 26.9 parts per million for bromin itself.

To test the accuracy of this method the following experiments were carried out:

I. Two grams of sodium chlorid, 18 mg of potassium bromid, and 1.6 mg of potassium iodid were dissolved in a liter of water. The water was evaporated with sodium carbonate, the residue dissolved in water, filtered, and made up to a known volume. Aliquot portions representing 500 cc of the original sample were taken for analysis. The analysis was run as above described (extracting with alcohol, determining iodin and bromin) and 9 mg of potassium bromid and 0.8 mg of potassium iodid were recovered, or 18 mg of potassium bromid and 1.6 mg of potassium iodid per liter.

II. Two grams of sodium chlorid, 4 mg of potassium bromid, and 0.8 mg of potassium iodid were dissolved in a liter of water. The same procedure was followed as in experiment I. Four mg of potassium bromid and 0.6 mg of potassium iodid were recovered.

III. Two artificial waters were then made up having the following composition:

*Composition of 3,000-gram samples of waters artificially made up for experiment.*

| Ingredients. | Sample I. | Sample II. | Ingredients. | Sample I. | Sample II. |
|---|---|---|---|---|---|
| | *Grams.* | *Grams.* | | *Grams.* | *Grams.* |
| Barium carbonate | 0.0505 | 0.0605 | Potassium bromid | 0.0312 | 0.0090 |
| Strontium carbonate | .0101 | .0101 | Potassium iodid | .0009 | .0003 |
| Calcium carbonate | 1.5000 | 1.5000 | Sodium chlorid | 3.6000 | 3.0000 |
| Magnesium sulphate | 1.0000 | 1.0000 | | | |

These waters were evaporated with sodium carbonate, the residues extracted with water, filtered, and made up to definite volumes. Such aliquot portions of the filtrates were taken for analysis as would represent one-third of the original sample. From these samples, containing in No. I 10.4 parts per million of potassium bromid and 0.3 part per million potassium iodid and in No. II 3 parts per million of potassium bromid and 0.1 part per million of potassium iodid, the following amounts of the two constituents were recovered: In No. I, 11 parts per million of potassium bromid and 0.25 part per million of potassium iodid, and in No. II, 3.5 parts per million of potassium bromid and 0.06 part per million of potassium iodid.

IV. Working on Blue Lick water the following results (expressed in parts per million) were obtained when the samples were run in triplicate and the amounts of water used for the determination varied: Potassium iodid, 0.17, 0.16, and 0.15; potassium bromid, 33.3, 33.4, and 36.

V. Working on Saratoga Champion the following duplicate results were obtained: Potassium iodid —0.2 and 0.25 parts per million, and potassium bromid 20 and 20 parts per million.

While the authors do not claim any great scientific exactness for the above method, they do believe that it gives fairly accurate results within its limits. It certainly permits the determination of much smaller amounts of iodin and bromin than can be made by any of the methods in common use, and thus avoids the tedious evaporation of large quantities of water and the consequent difficulties which arise from the presence of large quantities of salts in solution. Fortunately most mineral waters containing iodin and bromin fall within the limits of this method. In only four of the numerous samples examined was it necessary to resort to the gravimetric method of determination.

ARSENIC.

An aliquot portion of the alkaline filtrate (p. 22) is evaporated to dryness. It is then acidified with arsenic-free sulphuric acid and subjected to the action of arsenic-free zinc and sulphuric acid in a Marsh-Berzelius apparatus. The mirror obtained is compared with a mirror prepared from an arsenious oxid solution of known strength. The details of this method are given in a former publication.[a]

BORIC ACID.

A part of the alkaline filtrate (p. 22) is evaporated to dryness, treated with 1 or 2 cc of water, and slightly acidified with hydrochloric acid. About 25 cc of absolute alcohol is added, the solution is boiled and filtered, and the operation repeated. The filtrate is made slightly alkaline with sodium hydrate and evaporated to dryness. A very little water is added, the solution slightly acidified with hydrochloric acid, and a strip of turmeric paper placed in the liquid. The whole is evaporated to dryness on the steam bath and the heating continued until the turmeric paper becomes entirely dry. In case boric acid is present the turmeric paper takes on a cherry red color. Boric acid was not determined quantitatively in any of the samples reported. For the sake of completeness a reference is given to a most excellent quantitative method devised by Gooch.[b]

SILICA.

In this determination a large quantity of water is evaporated to dryness in platinum, with the occasional addition of small amounts of hydrochloric acid. After all the water has been evaporated to dryness the dish and contents are completely dried at 120° C. The residue is taken up with hydrochloric acid and water, heated, and filtered, washing the residue thoroughly with hot water. This process takes out most of the silica. The filtrate is then evaporated to dryness, dried thoroughly at 120° C., again taken up in hydrochloric acid solution by heat, and filtered. The filtrate is made to a definite volume, aliquot portions of which are used for the determination of iron, aluminum, manganese, calcium, magnesium, sulphuric acid, potassium, sodium, lithium, and phosphoric acid. The two residues are transferred to a crucible, burned, and blasted in the ordinary way, and finally weighed as silica.[c]

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[a] Haywood and Warner, Arsenic in Papers and Fabrics, U. S. Dept. Agr., Bureau of Chemistry, Bul. 86, p. 25.

[b] Amer. Chem. J., 9: 23.

[c] This was the procedure as followed in the subjoined analyses. The authors intend, however, in subsequent analyses to determine silica by the difference in weight between the residue and the residue after treatment with hydrofluoric and sulphuric acids.

IRON AND ALUMINUM.

An aliquot portion of the silica filtrate is treated with a little ammonium chlorid (to keep magnesia in solution) and then heated to boiling temperature. Ammonia is added a drop at a time until it can be very faintly smelled coming off from the solution. The solution is then boiled until the smell of ammonia has practically disappeared, filtered, washed with hot water, dried, burned, and weighed as ferric oxid ($Fe_2O_3$) and alumina ($Al_2O_3$). The filtrate is kept for the determination of calcium and magnesium.

IRON.

An aliquot portion of the silica filtrate is treated with 2 or 3 cc of concentrated sulphuric acid and evaporated to a sirupy consistency. It is then reduced with hydrogen by the addition of zinc, filtered, and iron determined in the filtrate by means of standard potassium permanganate.

MANGANESE.

An aliquot portion of the silica filtrate is treated just as described above for iron and aluminum, so as to eliminate these two elements. The ammoniacal filtrate resulting is treated with more ammonia and a few drops of bromin. The mixture is well stirred and boiled. The vessel is then removed from the source of heat, cooled slightly, and a little more ammonia and bromin added. This process repeated once or twice precipitates all the manganese as the oxid. The solution is made slightly acid with acetic acid, filtered, and washed with hot water. The filter and contents are burned and weighed as manganese tetroxid ($Mn_3O_4$).

CALCIUM AND MAGNESIUM.

The filtrate from iron and aluminum is treated with ammonium oxalate in the usual manner and allowed to stand over night. The liquid is filtered off, the precipitate dissolved in hydrochloric acid and reprecipitated with ammonia and a little extra ammonium oxalate. This is again allowed to stand over night and is filtered and washed on the same paper previously used. The precipitate is dried, transferred to a crucible, burned and blasted in the ordinary way, and finally weighed as calcium oxid. The combined filtrates are evaporated to dryness in platinum and the major part of the ammonium salts driven off by the aid of heat. The residue is dissolved in dilute hydrochloric acid and filtered. The filtrate is made slightly ammoniacal, enough sodium phosphate solution is added a drop at a time to precipitate all magnesium, and 10 cc of concentrated ammonia are finally added, drop by drop. The beaker is covered and allowed to stand over night, the contents filtered, washed with dilute ammonia water, dried, and blasted and weighed as magnesium pyrophosphate.

Another portion of the silica filtrate is precipitated while boiling with hot dilute barium chlorid, and after standing it is filtered from the precipitated barium sulphate, which is washed, dried, burned, and finally weighed in the ordinary manner.

The filtrate is evaporated to dryness and taken up with water. This solution is precipitated with a solution of barium hydrate and filtered off from the insoluble magnesium hydrate. The magnesium hydrate precipitate is well washed and the combined filtrate and washings treated with ammonia, ammonium carbonate, and a little ammonium oxalate to precipitate calcium and barium. This precipitate is allowed to stand over night, is filtered off, and well washed. The filtrate and washings are evaporated to dryness on the steam bath, dried, and all the ammonium salts driven off by a gentle heat. The residue is taken up with water, filtered through a small filter, using as little wash water as possible, evaporated to a small volume, and finally again precipitated with a drop of ammonia and two to three drops of ammonium carbonate and oxalate. If any precipitate appears, which is not usually the case, it is filtered off and the same process repeated. In any case the solution is filtered from the magnesium hydrate that precipitates out on concentrating the solution. The filtrate is then evaporated to dryness and all ammonium salts driven off by heating in platinum to a little below redness. The residue is taken up with a little water and filtered through a small filter, again using as little wash water as possible, and is again heated in platinum to a point slightly below red heat. By this time all of the magnesia should be removed. The residue is then taken up with a little water, filtered into a weighed platinum dish, treated with a few drops of hydrochloric acid, and evaporated to dryness. This residue is thoroughly dried, heated to a little below redness, cooled in a desiccator, and finally weighed as the combined chlorids of potassium, sodium, and lithium.

The determination of lithium is then made according to the method of Gooch;[a] i. e., the combined chlorids are dissolved in water and transferred to a small beaker, where they are again evaporated practically to dryness. About 30 cc of amyl alcohol are added and the contents of the beaker boiled until the temperature rises to approximately the boiling point of the amyl alcohol, showing that all of the water has been driven off. The liquid is cooled slightly and a drop of hydrochloric acid added to reconvert small amounts of lithium hydrate to lithium chlorid. The boiling is then continued to again drive off all water, until finally the liquid reaches a volume of about 15 cc. The amyl alcohol is then filtered off in a weighed platinum dish and the filter washed by running a little amyl alcohol into the dish. The amyl

[a] Amer. Chem. J., 9: 33.

alcohol is driven off from the filter and beaker in the air bath, and these two are kept for the determination of potassium and sodium. The contents of the platinum dish are evaporated to dryness, treated with a little sulphuric acid, and finally burned and weighed. This gives the weight of the lithium sulphate, from which is subtracted 0.0017 gram to correct for the solubility of the sodium and potassium chlorids in the amyl alcohol. The residue is finally tested with the spectroscope for the lithium line. (If lithium was found with the spectroscope, but was not present in a large enough quantity to be weighed, it was reported as a trace.)

The contents of the beaker and filter from which the amyl alcohol has been driven are then used for the determination of potassium and sodium. The contents of the beaker are dissolved in hot water and passed through the filter, which is thoroughly washed. The combined filtrate and washings are transferred to a porcelain dish, treated with platinum chlorid solution, and evaporated nearly to dryness. The residue is treated with 80 per cent alcohol and thoroughly washed on the filter with this medium until all the platinum chlorid has been washed out. The filter paper is dried at the temperature of boiling water and the residue dissolved in water and passed into a weighed platinum dish, from which the water is evaporated off, the dish and contents being dried at the temperature of boiling water, and finally weighed as potassium platinic chlorid. An addition of 0.0008 gram of potassium chlorid to the weight of this substance found is necessary.

The weight of the sodium chlorid is found by subtracting the combined weights of the lithium chlorid and the potassium chlorid (corrected) from the total weight of the three chlorids.

Of course if the amyl alcohol in the determination of lithium above is not evaporated to exactly 15 cc, the corrections will be different from those mentioned above.[a]

PHOSPHORIC ACID.

Another portion of the filtrate mentioned above is treated with about 10 cc of concentrated nitric acid and evaporated in a porcelain dish nearly to dryness to drive off hydrochloric acid. The residue is taken up with water and, if necessary, filtered. Ammonia is added to alkalinity and then just enough nitric acid to restore acidity. Some ammonium nitrate is added and the beaker heated in the water bath to 45° to 50° C. Molybdate solution is then added and the solution kept at a temperature of 45° to 50° C. for half an hour. The yellow precipitate formed at this point appears generally only in traces, but in a few cases it must be filtered off and washed with cold water until entirely free of nitric and molybdic acids. The precipitate and filter are then transferred to a beaker, a little water added,

[a] For the discussion of this point see original article by Gooch, loc. cit.

and the paper and contents beaten into a pulp. The yellow precipitate is then dissolved by the addition of a small amount of standard potassium hydroxid solution (1 cc = 1 mg of $P_2O_5$); phenolphthalein is added and the solution titrated with standard nitric acid solution of exactly the same strength as the alkaline solution. From the data so obtained the phosphoric acid ions in the water can be calculated in parts per million.[a]

BARIUM AND STRONTIUM.[b]

The washed residue remaining after evaporating a large quantity of the water with sodium carbonate and filtering is used for this determination. The filter and contents are dried and the contents transferred to a large platinum dish, the filter burned, and the ash added to the same platinum dish. The residue thus obtained is treated twice with sulphuric and hydrofluoric acid to get rid of silica, and the excess of these substances is driven off each time by heating with the full flame of a Bunsen burner. The residue is then fused with sodium carbonate (care being taken that the entire residue is acted upon) treated with water and a few drops of alcohol to dissolve the excess of sodium carbonate and sodium sulphate formed, filtered and carefully washed until all traces of sulphates disappear from the wash water. The contents of the filter is digested with hot dilute acetic acid to dissolve barium, strontium, magnesium, and calcium carbonates. It sometimes happens that at this point undissolved iron comes through the filter and can not be washed out. In such a case ammonia is added to the filtrate to alkalinity; it is then heated to coagulate the iron, filtered again, and washed. The filtrate is now made very slightly acid with acetic acid and about fifty times the weight of the combined sulphates is added in ammonium sulphate, which ammonium sulphate is dissolved in four times its weight of water. The whole is heated on the steam bath till the sulphates of barium and strontium settle out and is allowed to stand over night.

The precipitated sulphates are filtered and washed with a concentrated solution of ammonium sulphate till no more calcium is present in the wash water. The filter is ignited to a white ash, then treated with a few drops of sulphuric acid, ignited again, and weighed. The residue thus obtained consists of barium and strontium sulphates. This residue is then digested for twenty-four hours (with frequent stirring) with ammonium carbonate solution to change the strontium sulphate to strontium carbonate. The residue remaining is transferred to a filter, washed, and the strontium carbonate dissolved out with dilute hydrochloric acid. The residue is then washed, ignited as before, and finally weighed as barium sulphate. The difference between the last weight

[a] U. S. Dept. Agr., Bureau of Chemistry, Bul. 46, rev., p. 13.
[b] Gooch and Whitford, U. S. Geological Survey, Bul. 47.

and the total weight gives strontium sulphate. (To determine absolutely that strontium had been dissolved out and not calcium the small amount of hydrochloric acid extract was evaporated to a small volume and tested with the spectroscope. It occasionally happened that this very minute residue was weighable and yet consisted of calcium only, which had not been completely washed out.)

## II. COMMERCIAL WATERS.

### CHEMICAL COMPOSITION OF MISCELLANEOUS WATERS BOUGHT ON THE OPEN MARKET.

In the following tables are given the analyses of the leading springs of the United States the waters from which could be conveniently bought on the open market, together with the analyses advertised by the spring owner, or where these could not be obtained, the analyses given in Crook's Mineral Waters of the United States. The column in the tables headed "Bureau of Chemistry" gives the composition of the water as determined by the authors; the column headed "Advertised" contains the composition advertised by the spring owners; the column headed "Crook" records the analysis given in Crook's Mineral Waters of the United States; the column headed "Total inorganic material in solution" gives the percentage amount of each ion as found by the authors; and the column headed "Amount of water used for each determination" gives the amount of water used by the authors for each test. Under the caption "Hypothetical form of combination" is given the number, both in parts per million and in percentage, of ions combined in the form of salts as calculated from the authors' analysis.

No. 688.—*Poland Water, South Poland, Me.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 5.6; carbon dioxid (set free from bicarbonates on evaporating to dryness), 8.8.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 24.1 | 19.2 | 21.16 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 3.6 | 1.5 | 3.16 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 48.4 | | 42.50 | 100 |
| $CO_3$ (carbonic acid radicle) | | 20.6 | | |
| $NO_3$ (nitric acid radicle) | 5.89 | | 5.17 | 100 |
| $NO_2$ (nitrous acid radicle) | .0032 | | | 100 |
| $PO_4$ (phosphoric acid radicle) | Trace. | | | 500 |
| $BO_2$ (metaboric acid radicle) | None. | | | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 500 |
| Cl (chlorin) | 5.0 | 2.7 | 4.39 | 500 |
| Br (bromin) | None. | | | 1,000 |
| I (iodin) | None. | | | 1,000 |

No. 688.—*Poland Water, South Poland, Me.*—Continued.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| Fe, Al (iron and aluminum) | .4 | | .35 | 1,000 |
| Mn (manganese) | None. | | | 1,000 |
| Ca (calcium) | 13.9 | 8.4 | 12.21 | 1,000 |
| Mg (magnesium) | 2.1 | 2.7 | 1.84 | 1,000 |
| K (potassium) | 2.4 | 1.2 | 2.11 | 1,000 |
| Na (sodium) | 6.9 | 2.9 | 6.06 | 1,000 |
| Li (lithium) | (a) | | | 1,000 |
| $NH_4$ (ammonium) | .008 | | | 500 |
| Oxygen to form $SiO_3$ and $Fe_2O_3$ | 1.2 | | 1.05 | |
| Total | 113.9012 | 59.2 | 100.00 | |
| Free ammonia | .008 | | | |
| Albuminoid ammonia | .051 | | | |
| Nitrogen as nitrates | 1.33 | | | |
| Nitrogen as nitrites | .001 | | | |
| Oxygen required | .45 | | | |

a Minute trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.024 | 0.02 |
| LiCl (lithium chlorid) | (a) | |
| KCl (potassium chlorid) | 4.6 | 4.04 |
| NaCl (sodium chlorid) | 4.6 | 4.04 |
| $Na_2SO_4$ (sodium sulphate) | 5.3 | 4.65 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | |
| $NaNO_3$ (sodium nitrate) | 8.07 | 7.09 |
| $NaNO_2$ (sodium nitrite) | .0048 | |
| $Na(HCO_3)$ (sodium bicarbonate) | 4.4 | 3.86 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 12.6 | 11.06 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 46.1 | 40.48 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .6 | .53 |
| $CaSiO_3$ (calcium silicate) | 7.3 | 6.41 |
| $SiO_2$ (silica) | 20.3 | 17.82 |
| Total | 113.8988 | 100.00 |

a Minute trace.

No. 689.—*Massanetta water, Harrisonburg, Va.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 7.2; carbon dioxid (set free from bicarbonates on evaporating to dryness), 62.8+.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 12.4 | 16.2 | 2.69 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 2.8 | 5.1 | .61 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 342.2 | ..... | 74.28 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 209.7 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | 2.2 | ..... | .48 | 100 |
| $NO_2$ (nitrous acid radicle) | .0032 | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | Trace. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 1.8 | 1.11 | .39 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | ..... | ..... | 1,000 |
| Fe (iron) | ..... | 2.6 | ..... | ..... |
| Fe, Al (iron and aluminum) | .3 | ..... | .07 | 1,000 |
| $Al_2O_3$ (alumina) | ..... | 2.3 | ..... | ..... |
| Mn (manganese) | None. | .3 | ..... | 1,000 |
| Ca (calcium) | 63.4 | 86.2 | 13.76 | 1,000 |
| Mg (magnesium) | 28.2 | 28.6 | 6.12 | 1,000 |
| K (potassium) | 3.1 | 1.9 | .67 | 1,000 |
| Na (sodium) | 3.9 | 7.0 | .85 | 1,000 |
| Li (lithium) | (*a*) | Trace. | ..... | 1,000 |
| $NH_4$ (ammonium) | .185 | .06 | .04 | 500 |
| Oxygen to form $Fe_2O_3$ | .2 | ..... | .04 | ..... |
| Total | 460.6882 | 361.07 | 100.00 | ..... |
| Free ammonia | .175 | ..... | ..... | ..... |
| Albuminoid ammonia | .054 | ..... | ..... | ..... |
| N as nitrates | .5 | ..... | ..... | ..... |
| N as nitrites | .001 | ..... | ..... | ..... |
| Oxygen required | .45 | ..... | ..... | ..... |

*a* Minute trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.549 | 0.12 |
| LiCl (lithium chlorid) | (*a*) | ..... |
| KCl (potassium chlorid) | 2.9 | .63 |
| KBr (potassium bromid) | None. | ..... |
| KI (potassium iodid) | None. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 1.2 | .26 |
| $K_2SO_4$ (potassium sulphate) | 3.6 | .78 |
| $NaNO_3$ (sodium nitrate) | 3.0 | .65 |
| $NaNO_2$ (sodium nitrite) | .0048 | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 9.9 | 2.15 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 169.8 | 36.86 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 256.8 | 55.75 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .5 | .11 |
| $SiO_2$ (silica) | 12.4 | 2.69 |
| Total | 460.6538 | 100.00 |

*a* Minute trace.

No. 690.—*Veronica water, Santa Barbara, Cal.*

[Magnesic sulphated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), none; carbon dioxid (set free from bicarbonates on evaporating to dryness), 196.7.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 18.1 | | 0.08 | 1,000 |
| $SO_4$ (sulphuric acid radicle) | 12,361.0 | 15,780.6 | 54.10 | 100 |
| $HCO_3$ (bicarbonic acid radicle) | 1,052.7 | | 4.61 | 100 |
| $CO_3$ (carbonic acid radicle) | | 683.0 | | |
| $NO_3$ (nitric acid radicle) | 1,739.6 | 4,817.4 | 7.62 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | Trace. | | | 200 |
| $BO_2$ (metaboric acid radicle) | None. | | | 200 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 200 |
| Cl (chlorin) | 2,003.5 | 2,530.6 | 8.77 | 10 |
| Br (bromin) | None. | | | 200 |
| I (iodin) | (*a*) | | | 200 |
| Fe, Al (iron and aluminum) | 2.6 | | .01 | 500 |
| Mn (manganese) | None. | | | 500 |
| Ca (calcium) | 564.0 | 288.0 | 2.47 | 100 |
| Mg (magnesium) | 2,858.5 | 5,759.3 | 12.52 | 100 |
| K (potassium) | 88.8 | 47.4 | .39 | 100 |
| Na (sodium) | 2,152.7 | 2,763.0 | 9.43 | 100 |
| $NH_4$ (ammonium) | .08 | | | 200 |
| Oxygen to form $Fe_2O_3$ | 1.1 | | | |
| Total | 22,842.68 | 32,669.3 | 100.00 | |
| Free ammonia | .08 | | | |
| Albuminoid ammonia | 3.05 | | | |
| N as nitrates | 392.8 | | | |
| N as nitrites | None. | | | |
| Oxygen required | 25.0 | | | |

*a* Heavy trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.24 | |
| KCl (potassium chlorid) | 169.5 | 0.74 |
| NaCl (sodium chlorid) | 3,170.0 | 13.88 |
| KI (potassium iodid) | (*a*) | |
| $Na_2SO_4$ (sodium sulphate) | 802.7 | 3.51 |
| $MgSO_4$ (magnesium sulphate) | 14,151.4 | 61.95 |
| $CaSO_4$ (calcium sulphate) | 744.3 | 3.26 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | |
| $NaNO_3$ (sodium nitrate) | 2,384.9 | 10.44 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 1,397.8 | 6.12 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 3.7 | .02 |
| $SiO_2$ (silica) | 18.1 | .08 |
| Total | 22,842.64 | 100.00 |

*a* Heavy trace.

No. 691.—*Bedford mineral water, Bedford, Pa.*

[Calcic sulphated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 6.1; carbon dioxid (set free from bicarbonates on evaporating to dryness), 35.3.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 36.8 | 6.12 | 1.36 | 2.000 |
| $SO_4$ (sulphuric acid radicle) | 1,727.5 | 1,751.94 | 63.83 | 400 |
| $HCO_3$ (bicarbonic acid radicle) | 192.3 | ..... | 7.11 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 96.93 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | .21 | ..... | .01 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 400 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 10.0 | 10.59 | .40 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | ..... | ..... | 1,000 |
| $Fe_2O_3$ (ferric oxid) | ..... | .84 | ..... | ..... |
| Fe<br>Al (iron and aluminum) | 2.1 | ..... | .08 | 500 |
| $Al_2O_3$ (alumina) | ..... | 1.83 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 500 |
| Ca (calcium) | 570.0 | 543.62 | 21.06 | 200 |
| Mg (magnesium) | 138.6 | 141.35 | 5.12 | 200 |
| K (potassium) | 4.9 | 3.72 | .18 | 1,000 |
| Na (sodium) | 13.1 | 20.10 | .48 | 1,000 |
| Li (lithium) | Trace. | .61 | ..... | 1,000 |
| $NH_4$ (ammonium) | .015 | .28 | ..... | 500 |
| Oxygen to form $SiO_3$ and $Fe_2O_3$ | 10.1 | ..... | .37 | ..... |
| Total | 2,705.625 | 2,577.93 | 100.00 | ..... |
| Free ammonia | .014 | ..... | ..... | ..... |
| Albuminoid ammonia | .008 | ..... | ..... | ..... |
| Nitrogen as nitrates | .05 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |
| Oxygen required | .85 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.045 | ..... |
| $LiCl$ (lithium chlorid) | Trace. | ..... |
| $KCl$ (potassium chlorid) | 9.3 | 0.34 |
| $NaCl$ (sodium chlorid) | 9.2 | .34 |
| $Na_2SO_4$ (sodium sulphate) | 29.0 | 1.07 |
| $MgSO_4$ (magnesium sulphate) | 686.1 | 25.35 |
| $CaSO_4$ (calcium sulphate) | 1,643.9 | 60.76 |
| $NaBO_2$ (sodium metaborate) | Trace. | ..... |
| $NaNO_3$ (sodium nitrate) | .29 | .01 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 255.4 | 9.44 |
| $Fe_2O_3$<br>$Al_2O_3$ (ferric oxid and alumina) | 3.0 | .11 |
| $CaSiO_3$ (calcium silicate) | 68.1 | 2.52 |
| $SiO_2$ (silica) | 1.5 | .06 |
| Total | 2,705.835 | 100.00 |

No. 692.—*Tate Epsom water, Tate Springs, Tenn.*

[Calcic sulphated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 3.7; carbon dioxid (set free from bicarbonates on evaporating to dryness), 47.8.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 21.8 | 46.31 | 0.91 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 1,460.1 | 2,509.16 | 61.20 | 400 |
| $HCO_3$ (bicarbonic acid radicle) | 260.4 | ..... | 10.91 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 221.89 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | .21 | .34 | .01 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | 11.98 | ..... | 400 |
| $BO_2$ (metaboric acid radicle) | (a) | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 9.2 | 460.80 | .39 | 250 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | ..... | ..... | 1,000 |
| Fe (iron) | ..... | 17.69 | ..... | ..... |
| Fe, Al (iron and aluminum) | 2.9 | ..... | .12 | 500 |
| Mn (manganese) | None. | ..... | ..... | 500 |
| Ca (calcium) | 475.0 | 966.78 | 19.91 | 200 |
| Mg (magnesium) | 120.9 | 115.61 | 5.07 | 200 |
| K (potassium) | 8.2 | 11.85 | .34 | 1,000 |
| Na (sodium) | 25.4 | 318.69 | 1.06 | 1,000 |
| Li (lithium) | .1 | ..... | ..... | 1,000 |
| $NH_4$ (ammonium) | .01 | ..... | ..... | 500 |
| Oxygen to form $SiO_3$ and $Fe_2O_3$ | 1.8 | ..... | .08 | ..... |
| Total | 2,386.02 | 4,681.10 | 100.00 | ..... |
| Free ammonia | .01 | ..... | ..... | ..... |
| Albuminoid ammonia | .003 | ..... | ..... | ..... |
| Nitrogen as nitrates | .05 | ..... | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... | ..... |
| Oxygen required | .70 | ..... | ..... | ..... |

(a) Heavy trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.03 | ..... |
| LiCl (lithium chlorid) | .6 | 0.03 |
| KCl (potassium chlorid) | 15.7 | .66 |
| NaCl (sodium chlorid) | 2.0 | .08 |
| $Na_2SO_4$ (sodium sulphate) | 75.6 | 3.17 |
| $MgSO_4$ (magnesium sulphate) | 598.5 | 25.09 |
| $CaSO_4$ (calcium sulphate) | 1,319.5 | 55.30 |
| $NaNO_3$ (sodium nitrate) | .28 | .01 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 345.8 | 14.49 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 4.1 | .17 |
| $CaSiO_3$ (calcium silicate) | 4.3 | .18 |
| $SiO_2$ (silica) | 19.6 | .82 |
| Total | 2,386.01 | 100.00 |

## No. 869.—*Missisquoi water, Sheldon, Vt.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 0.25; carbon dioxid (set free from bicarbonates on evaporating to dryness), 38.9.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 43.1 | 15.25 | 12.18 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 16.9 | 19.63 | 4.78 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 212.0 | 174.98 | 59.89 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | | | 100 |
| $NO_2$ (nitrous acid radicle) | None. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | (*a*) | .05 | | 1,000 |
| $BO_2$ (metaboric acid radicle) | Trace. | | | 1,000 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 1,000 |
| Cl (chlorin) | 3.0 | 2.03 | .85 | 500 |
| Br (bromin) | None. | | | 1,000 |
| I (iodin) | None. | | | 1,000 |
| Fe (iron) | | .95 | .40 | |
| Fe, Al (iron and aluminum) | 1.4 | | | 500 |
| Al (aluminum) | | .43 | | |
| Mn (manganese) | .4 | .44 | .11 | 1,000 |
| Ca (calcium) | 45.1 | 35.57 | 12.73 | 500 |
| Mg (magnesium) | 14.0 | 13.29 | 3.96 | 500 |
| K (potassium) | 1.9 | 1.60 | .54 | 500 |
| Na (sodium) | 13.9 | 7.54 | 3.93 | 500 |
| Li (lithium) | Trace. | | | 500 |
| $NH_4$ (ammonium) | .037 | | .01 | 500 |
| Oxygen to form $Fe_2O_3$, $SiO_3$, and $Mn_3O_4$ | 2.2 | | .62 | |
| Total | 353.937 | 271.76 | 100.00 | |
| Free ammonia | .035 | | | |
| Albuminoid ammonia | None. | | | |
| Nitrogen as nitrates | Trace. | | | |
| Nitrogen as nitrites | None. | | | |
| Oxygen required | .20 | | | |

*a* Heavy trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.111 | 0.03 |
| LiCl (lithium chlorid) | Trace. | |
| KCl (potassium chlorid) | 3.6 | 1.02 |
| NaCl (sodium chlorid) | 2.0 | .57 |
| $Na_2SO_4$ (sodium sulphate) | 25.0 | 7.06 |
| $NaBO_2$ (sodium metaborate) | Trace. | |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | |
| $NaNO_3$ (sodium nitrate) | Trace. | |
| $Na(HCO_3)$ (sodium bicarbonate) | 18.3 | 5.17 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 84.3 | 23.82 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 170.5 | 48.17 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 2.2 | .62 |
| $Mn_3O_4$ (manganoso-manganic oxid) | .6 | .17 |
| $CaSiO_3$ (calcium silicate) | 8.7 | 2.46 |
| $SiO_2$ (silica) | 38.6 | 10.91 |
| Total | 353.911 | 100.00 |

No. 870.—*Wallawhatoola water, Millboro, Va.*

[Aluminic sulphated acid.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), none; carbon dioxid (set free from bicarbonates on evaporating to dryness), none.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 69.0 | 70 | 13.80 | 3,000 |
| $SO_4$ (sulphuric acid radicle) | 330.6 | 2,716.9 | 66 14 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | None. | ..... | ..... | 100 |
| $NO_3$ (nitric acid radicle) | 3.54 | ..... ..... | .71 | 100 |
| $NO_2$ (nitrous acid radicle) | .0024 | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | .6 | ..... | 600 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 3.6 | 7.4 | .72 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | (*a*) | ..... | ..... | 1,000 |
| Fe (iron) | 2.8 | 115.3 | .56 | 500 |
| Al (aluminum) | 45.3 | 388.1 | 9.06 | 500 |
| Mn (manganese) | 2.6 | 7.8 | .52 | 500 |
| Ca (calcium) | 11.4 | 38.3 | 2.28 | 500 |
| Mg (magnesium) | 13.8 | 52.9 | 2.76 | 500 |
| K (potassium) | 2.3 | 10.9 | .46 | 500 |
| Na (sodium) | 11.06 | 11.1 | 2.21 | 500 |
| Li (lithium) | .21 | .3 | .04 | 500 |
| $NH_4$ (ammonium) | .026 | ..... | ..... | 500 |
| Oxygen to form $SiO_3$ | 3.7 | ..... | .74 | ..... |
| Total | 499.9384 | 3,420.1 | 100.00 | ..... |
| Free ammonia | .025 | ..... | ..... | ..... |
| Albuminoid ammonia | .025 | ..... | ..... | ..... |
| Nitrogen as nitrates | .8 | ..... | ..... | ..... |
| Nitrogen as nitrites | .00075 | ..... | ..... | ..... |
| Oxygen required | .525 | ..... | ..... | ..... |
| Chlorin | 3.6 | ..... | ..... | ..... |

*a* Faint trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.077 | 0.01 |
| LiCl (lithium chlorid) | 1.2 | .24 |
| KCl (potassium chlorid) | 4.4 | .88 |
| NaCl (sodium chlorid) | .7 | .14 |
| KI (potassium iodid) | (*a*) | ..... |
| $Na_2SO_4$ (sodium sulphate) | 29.3 | 5.86 |
| $MgSO_4$ (magnesium sulphate) | 68.3 | 13.66 |
| $CaSO_4$ (calcium sulphate) | 7.9 | 1.58 |
| $FeSO_4$ (ferrous sulphate) | 7.6 | 1.52 |
| $Al_2(SO_4)_3$ (aluminum sulphate) | 286.9 | 57.39 |
| $MnSO_4$ (manganous sulphate) | 6.9 | 1.38 |
| $NaNO_3$ (sodium nitrate) | 4.85 | .97 |
| $NaNO_2$ (sodium nitrite) | .0036 | ..... |
| $CaSiO_3$ (calcium silicate) | 26.5 | 5.30 |
| $SiO_2$ (silica) | 55.3 | 11.07 |
| Total | 499.9306 | 100.00 |

*a* Faint trace.

No. 871.—*Jeffress lithia water, Jeffress, Va.*

[Sodic and calcic bicarbonated alkaline (silicious).]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 6.8; carbon dioxid (set free from bicarbonates on evaporating to dryness), 8.8.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 47.9 | 40.0 | 35.00 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 2.0 | 1.7 | 1.46 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 48.4 | 55.8 | 35.36 | 100 |
| $NO_3$ (nitric acid radicle) | 2.66 | ..... | 1.94 | 100 |
| $NO_2$ (nitrous acid radicle) | .003 | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | .4 | ..... | .29 | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 1,000 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 10.2 | 5.5 | 7.46 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | Trace. | ..... | ..... | 1,000 |
| $\left.\begin{matrix}Fe\\Al\end{matrix}\right\}$ (iron and aluminum) | 1.5 | ..... | 1.10 | 500 |
| Mn (manganese) | None. | ..... | ..... | 1,000 |
| Ca (calcium) | 8.0 | 9.0 | 5.84 | 500 |
| Mg (magnesium) | 4.1 | 3.4 | 2.99 | 500 |
| K (potassium) | 2.2 | 1.4 | 1.61 | 1,000 |
| Na (sodium) | 8.8 | 7.2 | 6.43 | 1,000 |
| Li (lithium) | Trace. | ..... | ..... | 1,000 |
| $NH_4$ (ammonium) | .016 | ..... | .01 | 500 |
| Oxygen to form $Fe_2O_3$ | .7 | ..... | .51 | ..... |
| Total | 136.879 | 124.0 | 100.00 | ..... |
| Free ammonia | .015 | ..... | ..... | ..... |
| Albuminoid ammonia | .007 | ..... | ..... | ..... |
| Nitrogen as nitrates | .60 | ..... | ..... | ..... |
| Nitrogen as nitrites | .001 | ..... | ..... | ..... |
| Oxygen required | .35 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.048 | 0.04 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 4.2 | 3.07 |
| NaCl (sodium chlorid) | 13.5 | 9.86 |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 3.0 | 2.19 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | .6 | .44 |
| $NaNO_3$ (sodium nitrate) | 3.65 | 2.67 |
| $NaNO_2$ (sodium nitrite) | .0045 | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 5.5 | 4.02 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 24.7 | 18.04 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 31.6 | 23.08 |
| $\left.\begin{matrix}Fe_2O_3\\Al_2O_3\end{matrix}\right\}$ (ferric oxid and alumina) | 2.2 | 1.61 |
| $SiO_2$ (silica) | 47.9 | 34.98 |
| Total | 136.9025 | 100.00 |

No. 872.—*Geneva lithia water, Geneva, N. Y.*

[Calcic sulphated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 0.8; carbon dioxid (set free from bicarbonates on evaporating to dryness), 45.1.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 14.2 | | 0.52 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 1,520.0 | 1,641.9 | 55.10 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 245.3 | 131.9 | 8.89 | 100 |
| $CO_3$ (carbonic acid radicle) | | 613.1 | | |
| $NO_3$ (nitric acid radicle) | .44 | | .02 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | Trace. | | | 500 |
| $BO_2$ (metaboric acid radicle) | Trace. | | | 1,000 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 1,000 |
| Cl (chlorin) | 204.5 | 233.3 | 7.41 | 100 |
| Br (bromin) | None. | | | 1,000 |
| I (iodin) | Trace. | | | 1,000 |
| Fe, Al (iron and aluminum) | .7 | | .03 | 400 |
| Al (aluminum) | | 3.7 | | |
| Mn (manganese) | None. | | | 500 |
| Ca (calcium) | 521.6 | 383.3 | 18.91 | 200 |
| Mg (magnesium) | 116.2 | 357.2 | 4.21 | 200 |
| K (potassium) | 4.0 | 154.4 | .15 | 500 |
| Na (sodium) | 131.1 | 153.5 | 4.75 | 500 |
| Li (lithium) | .1 | 23.8 | | 500 |
| $NH_4$ (ammonium) | .016 | | | 500 |
| Oxygen to form $Fe_2O_3$ | .3 | | .01 | |
| Total | 2,758.456 | 3,696.1 | 100.00 | |
| Free $NH_3$ | .015 | | | |
| Albuminoid ammonia | .015 | | | |
| Nitrogen as nitrates | .10 | | | |
| Nitrogen as nitrites | Trace. | | | |
| Oxygen required | .55 | | | |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.048 | |
| LiCl (lithium chlorid) | .6 | 0.02 |
| KCl (potassium chlorid) | 7.6 | .28 |
| NaCl (sodium chlorid) | 330.4 | 11.98 |
| KI (potassium iodid) | Trace. | |
| $Na_2SO_4$ (sodium sulphate) | 2.8 | .10 |
| $MgSO_4$ (magnesium sulphate) | 575.3 | 20.86 |
| $CaSO_4$ (calcium sulphate) | 1,500.2 | 54.37 |
| $NaBO_2$ (sodium metaborate) | Trace. | |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | |
| $NaNO_3$ (sodium nitrate) | .6 | .02 |
| $NaNO_2$ (sodium nitrite) | Trace. | |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 325.7 | 11.81 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 1.0 | .04 |
| $SiO_2$ (silica) | 14.2 | .52 |
| Total | 2,758.448 | 100.00 |

No. 873.—*Otterburn lithia water, Amelia Court House, Va.*

[Calcic bicarbonated, alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 11.9; carbon dioxid (set free from bicarbonates on evaporating to dryness), 20.5.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 43.1 | 41.90 | 21.44 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 2.8 | 1.8 | 1.39 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 112.0 | ..... | 55.73 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 47.6 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | Trace. | ..... | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | .003 | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | (*a*) | ..... | ..... | 800 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | ..... | 1,000 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 1,000 |
| Cl (chlorin) | 4.6 | 4.98 | 2.29 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | .06 | ..... | 1,000 |
| Fe (iron) | ..... | 1.1 | ..... | ..... |
| Fe, Al (iron and aluminum) | 1.5 | ..... | .75 | 500 |
| $Al_2O_3$ (alumina) | ..... | .6 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 600 |
| Ca (calcium) | 20.5 | 16.7 | 10.20 | 500 |
| Mg (magnesium) | 6.7 | 7.52 | 3.33 | 500 |
| K (potassium) | 1.9 | .6 | .95 | 1,000 |
| Na (sodium) | 7.8 | 5.14 | 3.88 | 1,000 |
| Li (lithium) | .03 | .1 | .01 | 1,000 |
| $NH_4$ (ammonium) | .069 | ..... | .03 | 500 |
| Total | 201.002 | 128.1 | 100.00 | ..... |
| Free ammonia | .065 | ..... | ..... | ..... |
| Albuminoid ammonia | .027 | ..... | ..... | ..... |
| Nitrogen as nitrates | Trace. | ..... | ..... | ..... |
| Nitrogen as nitrites | .001 | ..... | ..... | ..... |
| Oxygen required | .70 | ..... | ..... | ..... |

*a* Heavy trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.207 | 0.10 |
| LiCl (lithium chlorid) | .28 | .14 |
| KCl (potassium chlorid) | 3.6 | 1.79 |
| NaCl (sodium chlorid) | 4.3 | 2.14 |
| $Na_2SO_4$ (sodium sulphate) | 4.1 | 2.04 |
| $NaBO_2$ (sodium metaborate) | Trace. | ..... |
| $Ca_3(PO_4)_2$ (calcium phosphate) | (*a*) | ..... |
| $NaNO_3$ (sodium nitrate) | Trace. | ..... |
| $NaNO_2$ (sodium nitrite) | .0045 | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 17.5 | 8.70 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 40.3 | 20.04 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 82.9 | 41.23 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 4.8 | 2.39 |
| $SiO_2$ (silica) | 43.1 | 21.43 |
| Total | 201.0915 | 100.00 |

*a* Heavy trace.

No. 874.—*Powhatan water, Ballston, Va.*

[Sodic and calcic bicarbonated alkaline (silicious).]

*Gases* (number of cubic centimeters per 1,000 grams at 0°C. and 760 mm pressure).—Carbon dioxid (free), 6.7; carbon dioxid (set free from bicarbonates on evaporating to dryness), 2.2.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 12.0 | | 31.22 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 1.2 | | 3.12 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 12.0 | | 31.22 | 100 |
| $NO_3$ (nitric acid radicle) | 1.55 | | 4.03 | 100 |
| $NO_2$ (nitrous acid radicle) | .016 | | .04 | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | | | 800 |
| $BO_2$ (metaboric acid radicle) | None. | | | 1,000 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 1,000 |
| Cl (chlorin) | 3.8 | | 9.90 | 500 |
| Br (bromin) | None. | | | 1,000 |
| I (iodin) | Trace. | | | 1,000 |
| Fe, Al (iron and aluminum) | .2 | | .52 | 1,000 |
| Mn (manganese) | None. | | | 1,000 |
| Ca (calcium) | 1.6 | | 4.16 | 1,000 |
| Mg (magnesium) | 1.0 | | 2.60 | 1,000 |
| K (potassium) | 1.2 | | 3.12 | 1,000 |
| Na (sodium) | 3.7 | | 9.63 | 1,000 |
| Li (lithium) | None. | | | 1,000 |
| $NH_4$ (ammonium) | .069 | | .18 | 500 |
| Oxygen to form $Fe_2O_3$ | .10 | | .26 | |
| Total | 38.435 | 31.5 | 100.00 | |
| Free ammonia | .065 | | | |
| Albuminoid ammonia | None. | | | |
| Nitrogen as nitrates | .350 | | | |
| Nitrogen as nitrites | .005 | | | |
| Oxygen required | .45 | | | |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.207 | 0.54 |
| KCl (potassium chlorid) | 2.3 | 5.98 |
| NaCl (sodium chlorid) | 4.3 | 11.18 |
| KI (potassium iodid) | (*a*) | |
| $Na_2SO_4$ (sodium sulphate) | 1.8 | 4.68 |
| $NaNO_3$ (sodium nitrate) | 2.12 | 5.51 |
| $NaNO_2$ (sodium nitrite) | .024 | .06 |
| $Na(HCO_3)$ (sodium bicarbonate) | 2.9 | 7.54 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 6.0 | 15.61 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 6.5 | 16.91 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .3 | .78 |
| $SiO_2$ (silica) | 12.0 | 31.21 |
| Total | 38.451 | 100.00 |

*a* Faint trace.

No. 900.—*Buffalo lithia water, Buffalo Lithia Springs, Va.*

[Calcic sulphated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 0.2; carbon dioxid (set free from bicarbonates on evaporating to dryness), 15.5.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 34.9 | 4.41 | 4.67 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 405.2 | 452.62 | 54.21 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 84.8 | 204.53 | 11.35 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 181.99 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | 2.21 | ..... | .30 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | (*a*) | ..... | ..... | 800 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 11.0 | 65.01 | 1.47 | 250 |
| Br (bromin) | None. | ..... | ..... | 500 |
| I (iodin) | None. | ..... | ..... | 500 |
| Fe (iron) | ..... | 1.35 | ..... | ..... |
| Fe, Al (iron and aluminum) | .5 | ..... | .07 | 500 |
| Al (aluminum) | ..... | 20.45 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 500 |
| Ca (calcium) | 166.4 | 191.72 | 22.27 | 500 |
| Ba (barium) | ..... | 13.22 | ..... | ..... |
| Mg (magnesium) | 6.4 | 2.55 | .86 | 500 |
| K (potassium) | 4.0 | 236.58 | .54 | 500 |
| Na (sodium) | 30.7 | 27.63 | 4.11 | 500 |
| Li (lithium) | Trace. | 3.31 | ..... | 500 |
| $NH_4$ (ammonium) | .038 | ..... | ..... | 500 |
| Oxygen to form $Fe_2O_3$ and $SiO_3$ | 1.1 | ..... | .15 | ..... |
| Total | 747.248 | 1,405.37 | 100.00 | ..... |
| Free ammonia | .035 | ..... | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... | ..... |
| Nitrogen as nitrates | .50 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |
| Oxygen required | .60 | ..... | ..... | ..... |

*a* Heavy trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.114 | 0.02 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 7.6 | 1.02 |
| NaCl (sodium chlorid) | 12.0 | 1.61 |
| $Na_2SO_4$ (sodium sulphate) | 77.7 | 10.40 |
| $MgSO_4$ (magnesium sulphate) | 31.7 | 4.24 |
| $CaSO_4$ (calcium sulphate) | 463.8 | 62.05 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | (*a*) | ..... |
| $NaNO_3$ (sodium nitrate) | 3.03 | .41 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 112.6 | 15.07 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .7 | .09 |
| $CaSiO_3$ (calcium silicate) | 6.4 | .86 |
| $SiO_2$ (silica) | 31.6 | 4.23 |
| Total | 747.244 | 100.00 |

*a* Heavy trace.

No. 901.—*Hathorn water, Saratoga, N. Y.*

[Sodic muriated alkaline-saline (ferruginous, lithic, bromic, iodic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), excess; carbon dioxid (set free from bicarbonates on evaporating to dryness), 761.2.

| Formula and name. | Bureau of Chemistry. | Crook. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 16.5 | 21.6 | 0.13 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 3.4 | ..... | .03 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 4,147.1 | 4,990.7 | 31.48 | 100 |
| $NO_3$ (nitric acid radicle) | None. | ..... | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 100 |
| $BO_4$ (metaboric acid radicle) | (a) | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 4,674.7 | 5,383.3 | 35.49 | 25 |
| Br (bromin) | 47.1 | 20.4 | .36 | 1.000 |
| I (iodin) | 1.7 | 2.8 | .01 | 500 |
| Fe (iron) | ..... | 6.1 | ..... | ..... |
| Fe, Al (iron and aluminum) | 6.7 | ..... | .05 | 100 |
| $Al_2O_3$ (alumina) | ..... | 2.2 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 500 |
| Ca (calcium) | 765.0 | 722.7 | 5.81 | 100 |
| Ba (barium) | 7.5 | 15.7 | .06 | 1,500 |
| Mg (magnesium) | 328.0 | 497.5 | 2.49 | 100 |
| K (potassium) | 197.8 | 83.6 | 1.50 | 500 |
| Na (sodium) | 2,951.8 | 3,471.5 | 22.41 | 500 |
| Li (lithium) | 7.4 | 20.2 | .06 | 500 |
| $NH_4$ (ammonium) | 12.76 | ..... | .10 | 200 |
| Oxygen to form $Fe_2O_3$ | 2.90 | ..... | .02 | ..... |
| Total | 13,170.36 | 15,238.3 | 100.00 | ..... |
| Albuminoid ammonia | .025 | ..... | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |

(a) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 37.89 | 0.29 |
| LiCl (lithium chlorid) | 44.9 | .34 |
| KCl (potassium chlorid) | 332.5 | 2.52 |
| NaCl (sodium chlorid) | 7,343.7 | 55.76 |
| KBr (potassium bromid) | 70.0 | .53 |
| KI (potassium iodid) | 2.2 | .02 |
| $Na_2SO_4$ (sodium sulphate) | 5.0 | .04 |
| $NaBO_2$ (sodium metaborate) | (a) | ..... |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 220.9 | 1.68 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 1,974.7 | 14.99 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 3,098.3 | 23.52 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 14.2 | .11 |
| $Sr(HCO_3)_2$ (strontium bicarbonate) | Trace. | ..... |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 9.6 | .07 |
| $SiO_2$ (silica) | 16.5 | .13 |
| Total | 13,170.39 | 100.00 |

(a) Small amount.

## No. 902.—*Congress water, Saratoga, N. Y.*

[Sodic muriated alkaline-saline (ferruginous, lithic, bromic, iodic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), excess; carbon dioxid (set free from bicarbonates on evaporating to dryness), 655.9.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 19.8 | 11.5 | 0.19 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 8.7 | 5.2 | .09 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 3,573.3 | 4,149.7 | 34.93 | 10 |
| $NO_3$ (nitric acid radicle) | None. | | | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | | | 500 |
| $BO_2$ (metaboric acid radicle) | (a) | | | 500 |
| Cl (chlorin) | 3,327.9 | 5,939.4 | 32.52 | 100 |
| Br (bromin) | 26.8 | 128.7 | .26 | 200 |
| I (iodin) | .8 | 3.6 | .01 | 500 |
| Fe (iron) | | 3.9 | | |
| Fe, Al (iron and aluminum) | 14.7 | | .14 | 100 |
| $Al_2O_3$ (alumina) | | .8 | | |
| Mn (manganese) | None. | | | 200 |
| Ca (calcium) | 562.1 | 634.5 | 5.49 | 100 |
| Ba (barium) | 7.1 | 8.8 | .07 | 2,000 |
| Mg (magnesium) | 278.2 | 389.4 | 2.72 | 100 |
| K (potassium) | 192.0 | 238.9 | 1.88 | 500 |
| Na (sodium) | 2,199.3 | 3,810.1 | 21.49 | 500 |
| Li (lithium) | 5.4 | 9.4 | .05 | 500 |
| $NH_4$ (ammonium) | 10.32 | | .10 | 200 |
| O to form $Fe_2O_3$ | 6.3 | | .06 | |
| Total | 10,232.72 | 15,333.9 | 100.00 | |
| Albuminoid ammonia | None. | | | |
| Nitrogen as nitrates | None. | | | |
| Nitrogen as nitrites | Trace. | | | |

(a) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 30.64 | 0.30 |
| LiCl (lithium chlorid) | 32.7 | .32 |
| KCl (potassium chlorid) | 340.5 | 3.33 |
| NaCl (sodium chlorid) | 5,141.6 | 50.24 |
| KBr (potassium bromid) | 40.0 | .39 |
| KI (potassium iodid) | 1.0 | .01 |
| $Na_2SO_4$ (sodium sulphate) | 12.9 | .12 |
| $NaBO_2$ (sodium metaborate) | (a) | |
| $NaNO_2$ (sodium nitrite) | Trace. | |
| $Na(HCO_3)$ (sodium bicarbonate) | 627.8 | 6.14 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 1,674.9 | 16.38 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 2,276.5 | 22.25 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 13.4 | .13 |
| $Sr(HCO_3)_2$ (strontium bicarbonate) | Trace. | |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 21.0 | .20 |
| $SiO_2$ (silica) | 19.8 | .19 |
| Total | 10,232.74 | 100.00 |

(a) Small amount.

No. 903.—*Vichy water, Saratoga, N. Y.*

[Sodic muriated alkaline-saline, carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free) excess; carbon dioxid (set free from bicarbonates on evaporating to dryness), 142.8.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 16.2 | 13.0 | 0.62 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 20.2 | ..... | .77 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 778.2 | 2,883.5 | 29.60 | 100 |
| $NO_3$ (nitric acid radicle) | None. | ..... | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | (*a*) | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 915.0 | 1,453.5 | 34.80 | 100 |
| Br (bromin) | Trace. | 13.2 | ..... | 500 |
| I (iodin) | Trace. | ..... | ..... | 500 |
| Fe (iron) | ..... | .3 | ..... | ..... |
| Fe, Al (iron and aluminum) | 2.24 | ..... | .09 | 500 |
| $Al_2O_3$ (alumina) | ..... | 12.7 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 200 |
| Ca (calcium) | 48.70 | 404.5 | 1.85 | 500 |
| Ba (barium) | ..... | 5.4 | ..... | ..... |
| Mg (magnesium) | 10.10 | 127.0 | .38 | 500 |
| K (potassium) | 3.91 | 127.3 | .15 | 500 |
| Na (sodium) | 828.8 | 1,262.4 | 31.53 | 500 |
| Li (lithium) | .12 | 3.1 | ..... | 500 |
| $NH_4$ (ammonium) | .89 | ..... | .03 | 200 |
| Oxygen to form $SiO_3$ and $Fe_2O_3$ | 4.80 | ..... | .18 | ..... |
| Total | 2,629.16 | 6,305.9 | 100.00 | ..... |
| Free ammonia | .841 | ..... | ..... | ..... |
| Albuminoid ammonia | .092 | ..... | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... | ..... |
| Oxygen required | 1.68 | ..... | ..... | ..... |

(*a*) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 2.64 | 0.10 |
| LiCl (lithium chlorid) | .6 | .02 |
| KCl (potassium chlorid) | 7.4 | .28 |
| NaCl (sodium chlorid) | 1,499.1 | 57.02 |
| KBr (potassium bromid) | Trace. | ..... |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 29.9 | 1.14 |
| $NaBO_2$ (sodium metaborate) | (*a*) | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 837.1 | 31.85 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 60.8 | 2.31 |
| $Ca(HCO_3S)_2$ (calcium bicarbonate) | 158.8 | 6.04 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 3.2 | .12 |
| $CaSIO_3$ (calcium silicate) | 27.6 | 1.05 |
| $SiO_2$ (silica) | 1.9 | .07 |
| Total | 2,629.04 | 100.00 |

(*a*) Small amount.

## No. 904.—*Mardela water, Mardela Springs, Md.*

[Ferruginous and calcic bicarbonated alkaline (aluminic) carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C and 760 mm pressure).—Carbon dioxid (free), excess: carbon dioxid (set free from bicarbonates on evaporating to dryness), 8.4.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 20.1 | 22.0 | 14.10 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 18.1 | .14 | 12.69 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 45.4 | ..... | 31.84 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 14.49 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | .22 | ..... | .15 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | (*a*) | ..... | ..... | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | Trace. | .02 | ..... | 500 |
| Cl (chlorin) | 16.0 | 8.1 | 11.22 | 100 |
| Br (bromin) | None. | ..... | ..... | 500 |
| I (iodin) | None. | ..... | ..... | 500 |
| Al (aluminum) | 5.0 | ..... | 3.51 | 250 |
| Fe (iron) | 13.6 | 138 1 | 9.54 | 250 |
| $Al_2O_3$ (alumina) | ..... | 6.0 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 1,000 |
| Ca (calcium) | 10.7 | 9.34 | 7.50 | 500 |
| Mg (magnesium) | 1.5 | .17 | 1.05 | 500 |
| K (potassium) | 2.1 | ..... | 1.47 | 1,000 |
| Na (sodium) | 4.9 | 5.34 | 3.44 | 1,000 |
| Li (lithium) | Trace. | ..... | ..... | 1,000 |
| $NH_4$ (ammonium) | .169 | ..... | .12 | 500 |
| Oxygen to form $Fe_2O_3$, etc | 4.80 | 59.2 | 3.37 | ..... |
| Total | 142.589 | 262.90 | 100.00 | ..... |
| Free ammonia | .16 | ..... | ..... | ..... |
| Albuminoid ammonia | .085 | ..... | ..... | ..... |
| Nitrogen as nitrates | .05 | ..... | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... | ..... |

*a* Heavy trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.507 | 0.36 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 4.0 | 2.81 |
| NaCl (sodium chlorid) | 12.2 | 8.56 |
| $AlCl_3$ (aluminum chlorid) | 8.0 | 5.61 |
| $Al_2(SO_4)_3$ (aluminum sulphate) | 21.5 | 15.07 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | ..... |
| $Na_2HAsO_4$ (di-sodium arsenate) | Trace. | ..... |
| $NaNO_3$ (sodium nitrate) | .3 | .21 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 9.0 | 6.31 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 43.3 | 30.36 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 7.7 | 5.40 |
| $Fe_2O_3$ (ferric oxid) | 16.0 | 11.22 |
| $SiO_2$ (silica) | 20.1 | 14.09 |
| Total | 142.607 | 100.00 |

No. 905.—*Vitan table water, Maryland.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C and 760 mm pressure).—Carbon dioxid (free), none; carbon dioxid (set free from bicarbonates on evaporating to dryness), 11.4.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 14.76 | 5.4 | 10.57 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 16.2 | 33.6 | 11.60 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 62.1 | 10.05 | 44.44 | 100 |
| $CO_3$ (carbonic radicle) | 2.9 | ..... | 2.08 | 100 |
| $NO_3$ (nitric acid radicle) | .88 | ..... | .63 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 5.0 | 3.0 | 3.58 | 100 |
| Br (bromin) | None. | ..... | ..... | 500 |
| I (iodin) | (a) | ..... | ..... | 500 |
| Fe, Al (iron and aluminum) | .9 | 4.6 | .64 | 1,000 |
| Mn (manganese) | None. | ..... | ..... | 1,000 |
| Ca (calcium) | 15.86 | 7.5 | 11.35 | 1,000 |
| Mg (magnesium) | 2.4 | 3.8 | 1.72 | 1,000 |
| K (potassium) | 10.5 | ..... | 7.52 | 1,000 |
| Na (sodium) | 7.8 | 2.05 | 5.58 | 1,000 |
| Li (lithium) | (a) | ..... | ..... | 1,000 |
| $NH_4$ (ammonium) | None. | ..... | ..... | 500 |
| Oxygen to form $Fe_2O_3$ | .4 | ..... | .29 | ..... |
| Total | 139.70 | 70.0 | 100.00 | ..... |
| Free ammonia | None. | None. | ..... | ..... |
| Albuminoid ammonia | .05 | None. | ..... | ..... |
| Nitrogen as nitrates | .20 | Trace. | ..... | ..... |
| Nitrogen as nitrites | None. | None. | ..... | ..... |
| Oxygen required | .45 | .60 | ..... | ..... |

a Faint trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| LiCl (lithium chlorid) | (a) | ..... |
| KCl (potassium chlorid) | 10.5 | 7.51 |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 14.9 | 10.66 |
| $K_2SO_4$ (potassium sulphate) | 11.1 | 7.94 |
| $NaNO_3$ (sodium nitrate) | 1.2 | .86 |
| $Na(HCO_3)$ (sodium bicarbonate) | 9.9 | 7.08 |
| $Mg(HCO_3)_2$ (Magnesium bicarbonate) | 14.5 | 10.37 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 56.8 | 40.63 |
| $CaCO_3$ (calcium carbonate) | 4.8 | 3.43 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 1.3 | .93 |
| $SiO_2$ (silica) | 14.8 | 10.59 |
| Total | 139.8 | 100.00 |

a Faint trace.

No. 1009.—*Blue Lick water, Blue Lick Springs, Ky.*

[Sodic muriated saline (bromic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C and 760 mm pressure).—Carbon dioxid (free), 129.9; carbon dioxid (set free from bicarbonates on evaporating to dryness), 75.6.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 18.1 | 17.9 | 0.20 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 340.4 | 474.4 | 3.77 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 411.8 | ..... | 4.56 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 234.6 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | 2.21 | ..... | .02 | 100 |
| $NO_2$ (nitrous acid radicle) | (*a*) | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | (*a*) | ..... | ..... | 500 |
| Alumina, calcium phosphate, and ferric oxid | ..... | 5.8 | ..... | ..... |
| $BO_2$ (metaboric acid radicle) | (*b*) | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 4,900.0 | 5,470.0 | 54.32 | 100 |
| Br (bromin) | 23.0 | 3.4 | .25 | 200 |
| I (iodin) | .14 | .7 | ..... | 500 |
| Fe, Al (iron and aluminum) | 1.0 | ..... | .01 | 500 |
| Mn (manganese) | 2.6 | ..... | .03 | 200 |
| Ca (calcium) | 342.7 | 314.7 | 3.80 | 500 |
| Mg (magnesium) | 178.9 | 134.7 | 1.98 | 500 |
| K (potassium) | 81.0 | 80.0 | .90 | 250 |
| Na (sodium) | 2,717.5 | 3,281.8 | 30.12 | 250 |
| Li (lithium) | 1.8 | ..... | .02 | 250 |
| $NH_4$ (ammonium) | .75 | ..... | ..... | 200 |
| Oxygen to form $Fe_2O_3$ and $Mn_3O_4$ | 1.44 | ..... | .02 | ..... |
| Total | 9,023.34 | 10,018.0 | 100.00 | ..... |

(*a*) Faint trace. (*b*) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 2.23 | 0.02 |
| LiCl (lithium chlorid) | 10.9 | .12 |
| KCl (potassium chlorid) | 133.1 | 1.48 |
| NaCl (sodium chlorid) | 6,904.0 | 76.52 |
| $MgCl_2$ (magnesium chlorid) | 700.9 | 7.77 |
| $CaCl_2$ (calcium chlorid) | 182.7 | 2.02 |
| KBr (potassium bromid) | 34.2 | .38 |
| KI (potassium iodid) | .17 | ..... |
| $CaSO_4$ (calcium sulphate) | 482.2 | 5.34 |
| $NaBO_2$ (sodium metaborate) | (*a*) | ..... |
| $Ca_3(PO_4)_2$ (calcium phosphate) | (*b*) | ..... |
| $NaNO_3$ (sodium nitrate) | 3.03 | .03 |
| $NaNO_2$ (sodium nitrite) | (*b*) | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 546.8 | 6.06 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 1.43 | .02 |
| $Mn_3O_4$ (mangano-manganic oxid) | 3.61 | .04 |
| $SiO_2$ (silica) | 18.1 | .20 |
| Total | 9,023.37 | 100.00 |

(*a*) Small amount. (*b*) Faint trace.

No. 1010.—*Sublett lithia water, Danville, Va.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 60.1; carbon dioxid (set free from bicarbonates on evaporating to dryness), 30.6.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 30.6 | 29.5 | 10.51 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 5.9 | 8.7 | 2.03 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 166.5 | 216.22 | 57.16 | 100 |
| $NO_3$ (nitric acid radicle) | 7.08 | ..... | 2.43 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 1,000 |
| Cl (chlorin) | 10.0 | 17.8 | 3.43 | 100 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | .085 | ..... | 1,000 |
| Fe (iron) | ..... | 2.3 | ..... | ..... |
| Fe, Al (iron and aluminum) | 1.0 | ..... | .34 | 500 |
| $Al_2O_3$ (alumina) | ..... | .1 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 500 |
| Ca (calcium) | 37.1 | 83.0 | 12.74 | 500 |
| Mg (magnesium) | 12.5 | 26.9 | 4.29 | 500 |
| K (potassium) | 2.6 | 3.6 | .89 | 1,000 |
| Na (sodium) | 14.8 | 20.515 | 5.08 | 1,000 |
| Li (lithium) | Trace. | .08 | ..... | 1,000 |
| $NH_4$ (ammonium) | .005 | ..... | ..... | 500 |
| Oxygen to form $SiO_3$ and $Fe_2O_3$ | 3.2 | ..... | 1.10 | ..... |
| Total | 291.285 | 408.8 | 100.00 | ..... |
| Free ammonia | .005 | ..... | ..... | ..... |
| Albuminoid ammonia | .055 | ..... | ..... | ..... |
| Nitrogen as nitrates | 1.60 | ..... | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... | ..... |
| Oxygen required | .325 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.015 | ..... |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 5.0 | 1.72 |
| NaCl (sodium chlorid) | 12.5 | 4.29 |
| $Na_2SO_4$ (sodium sulphate) | 8.7 | 2.99 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | ..... |
| $NaNO_3$ (sodium nitrate) | 9.71 | 3.33 |
| $Na(HCO_3)$ (sodium bicarbonate) | 16.4 | 5.63 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 75.2 | 25.82 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 122.0 | 41.87 |
| $Fe_2O_3$, $Al_2O_3$ (Ferric oxid and alumina) | 1.4 | .48 |
| $CaSiO_3$ (calcium silicate) | 20.4 | 7.00 |
| $SiO_2$ (silica) | 20.0 | 6.87 |
| Total | 291.325 | 100.00 |

## No. 1011.—*Osceola water, Pleasant Valley, Va.*

[Calcic and magnesic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 38; carbon dioxid (set free from bicarbonates on evaporating to dryness), 57.8.

| Formula and name. | Bureau of Chemistry. | Advertised | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 19.6 | 9.5 | 4.51 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 1.6 | 8.2 | .37 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 314.9 | ..... | 72.54 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 199.7 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | 3.99 | ..... | .92 | 100 |
| $NO_2$ (nitrous acid radicle) | (*a*) | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 1,000 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 1,000 |
| Cl (chlorin) | 3.4 | 1.0 | .78 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | ..... | ..... | 1,000 |
| Fe (iron) | ..... | 2.3 | ..... | ..... |
| Fe, Al (iron and aluminum) | .14 | ..... | .03 | 500 |
| $Al_2O_3$ (alumina) | ..... | 1.3 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 500 |
| Ca (calcium) | 52.8 | 73.8 | 12.16 | 500 |
| Mg (magnesium) | 28.6 | 33.4 | 6.59 | 500 |
| K (potassium) | 2.0 | 1.5 | .46 | 1,000 |
| Na (sodium) | 7.05 | 6.7 | 1.62 | 1,000 |
| Li (lithium) | None. | ..... | .01 | 1,000 |
| $NH_4$ (ammonium) | .04 | ..... | .01 | 500 |
| Oxygen to form $Fe_2O_3$ | .06 | ..... | ..... | ..... |
| $CO_2$ to form bicarbonates | ..... | 146.5 | ..... | ..... |
| Total | 434.18 | 483.9 | 100.00 | ..... |
| Free ammonia | .04 | ..... | ..... | ..... |
| Albuminoid ammonia | .01 | ..... | ..... | ..... |
| Nitrogen as nitrates | .90 | ..... | ..... | ..... |
| Nitrogen as nitrites | (*a*) | ..... | ..... | ..... |
| Oxygen required | .55 | ..... | ..... | ..... |

*a* Minute trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.12 | 0.03 |
| KCl (potassium chlorid) | 3.8 | .88 |
| NaCl (sodium chlorid) | 2.4 | .55 |
| $Na_2SO_4$ (sodium sulphate) | 2.4 | .55 |
| $NaNO_3$ (sodium nitrate) | 5.47 | 1.26 |
| $NaNO_2$ (sodium nitrite) | (*a*) | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 14.2 | 3.27 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 172.2 | 39.66 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 213.8 | 49.24 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .2 | .05 |
| $SiO_2$ (silica) | 19.6 | 4.51 |
| Total | 434.19 | 100.00 |

*a* Minute trace.

No. 1012.—*Golindo lithia water, Staunton, Va*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters for 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 19.6; carbon dioxid (set free from bicarbonates on evaporating to dryness), 61.1.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 12.2 | 37.50 | 2.45 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 33.0 | 32.77 | 6.64 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 333.1 | ..... | 67.00 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 186.32 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | 3.54 | ..... | .71 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | .05 | ..... | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 1,000 |
| Cl (chlorin) | 3.4 | 1.75 | .68 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | ..... | ..... | 1,000 |
| Fe (iron) | ..... | .33 | ..... | ..... |
| Fe, Al (iron and aluminum) | .3 | ..... | .06 | 500 |
| $Al_2O_3$ (alumina) | ..... | .33 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 500 |
| Ca (calcium) | 74.1 | 65.31 | 14.90 | 500 |
| Mg (magnesium) | 28.7 | 41.64 | 5.77 | 500 |
| Sr (strontium) | ..... | .03 | ..... | ..... |
| K (potassium) | 3.4 | 3.33 | .68 | 1,000 |
| Na (sodium) | 4.7 | 3.10 | .95 | 1,000 |
| Li (lithium) | .1 | .08 | .02 | 1,000 |
| $NH_4$ (ammonium) | None. | ..... | ..... | 500 |
| Oxygen to form $Fe_2O_3$ and $SiO_3$ | .7 | ..... | .14 | ..... |
| Total | 497.24 | 372.54 | 100.00 | ..... |
| Free ammonia | .000 | ..... | ..... | ..... |
| Albuminoid ammonia | .025 | ..... | ..... | ..... |
| Nitrogen as nitrates | .800 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |
| Oxygen required | .575 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| LiCl (lithium chlorid) | 0.6 | 0.12 |
| KCl (potassium chlorid) | 6.1 | 1.23 |
| $Na_2SO_4$ (sodium sulphate) | 10.5 | 2.11 |
| $K_2SO_4$ (potassium sulphate) | .4 | .08 |
| $MgSO_4$ (magnesium sulphate) | 32.2 | 6.47 |
| $NaNO_3$ (sodium nitrate) | 4.85 | .98 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 133.7 | 26.89 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 294.3 | 59.19 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .4 | .08 |
| $CaSiO_3$ (calcium silicate) | 4.1 | .82 |
| $SiO_2$ (silica) | 10.1 | 2.03 |
| Total | 497.25 | 100.00 |

## No. 1013.—*Cherrydale water, Cherrydale, Va.*

[Sodic and calcic, nitrated and muriated, saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 4; carbon dioxid (set free from bicarbonates on evaporating to dryness), 4.4.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 22.7 | 6.38 | 3,000 |
| $SO_4$ (sulphuric acid radicle) | 4.0 | 1.12 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 24.2 | 6.80 | 100 |
| $NO_3$ (nitric acid radicle) | 132.9 | 37.33 | 100 |
| $NO_2$ (nitrous acid radicle) | .0024 | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 900 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | 1,000 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 1,000 |
| Cl (chlorin) | 76.0 | 21.35 | 100 |
| Br (bromin) | None. | ..... | 1,000 |
| I (iodin) | Trace. | ..... | 1,000 |
| Fe\| Al (iron and aluminum) | .7 | .20 | 500 |
| Mn (manganese) | None. | ..... | 500 |
| Ca (calcium) | 34.9 | 9.80 | 500 |
| Mg (magnesium) | 16.0 | 4.49 | 500 |
| K (potassium) | 4.1 | 1.15 | 1,000 |
| Na (sodium) | 39.2 | 11.01 | 1,000 |
| Li (lithium) | Trace. | ..... | 1,000 |
| $NH_4$ (ammonium) | .11 | .03 | 500 |
| Oxygen to form $Fe_2O_3$ and $SiO_3$ | 1.20 | .34 | ..... |
| Total | 356.0124 | 100.00 | ..... |
| Free ammonia | .10 | ..... | ..... |
| Albuminoid ammonia | .037 | ..... | ..... |
| Nitrogen as nitrates | 30.0 | ..... | ..... |
| Nitrogen as nitrites | .00075 | ..... | ..... |
| Oxygen required | .775 | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.33 | 0.09 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 7.8 | 2.19 |
| NaCl (sodium chlorid) | 41.9 | 11.77 |
| $MgCl_2$ (magnesium chlorid) | 64.0 | 17.97 |
| KI (potassium iodid) | Trace. | ..... |
| $CaSO_4$ (calcium sulphate) | 5.7 | 1.60 |
| $NaNO_3$ (sodium nitrate) | 144.9 | 40.70 |
| $Mg(NO_3)_2$ (magnesium nitrate) | 32.5 | 9.13 |
| $NaNO_2$ (sodium nitrite) | .0036 | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 32.1 | 9.02 |
| $Fe_2O_3$\| $Al_2O_3$ (ferric oxid and alumina) | 1.0 | .28 |
| $CaSiO_3$ (calcium silicate) | 6.4 | 1.80 |
| $SiO_2$ (silica) | 19.4 | 5.45 |
| Total | 356.0336 | 100.00 |

## No. 1020.—*Deep Rock water, Oswego, N. Y.*

[Sodic muriated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 3.1; carbon dioxid (set free from bicarbonates on evaporating to dryness), 39.4.

| Formula and name. | Bureau of Chemistry. | Crook. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 10.6 | 1,229.85 | 0.46 | 3,000 |
| $SO_4$ (sulphuric acid radicle) | 38.8 | | 1.67 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 215.0 | | 9.24 | 100 |
| $NO_3$ (nitric acid radicle) | 8.85 | | .38 | 100 |
| $NO_2$ (nitrous acid radicle) | .0032 | | | 100 |
| $PO_4$ (phosphoric acid radicle) | Trace. | | | 900 |
| $BO_2$ (metaboric acid radicle) | None. | | | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 500 |
| Cl (chlorin) | 1,185.0 | 4,752.25 | 50.94 | 100 |
| Br (bromin) | None. | | | 500 |
| I (iodin) | None. | | | 500 |
| Fe, Al (iron and aluminum) | .3 | | .01 | 500 |
| Mn (manganese) | None. | | | 300 |
| Ca (calcium) | 13.1 | 112.53 | .56 | 500 |
| Mg (magnesium) | 3.5 | 44.83 | .15 | 500 |
| K (potassium) | 3.6 | 1,341.18 | .15 | 500 |
| Na (sodium) | 847.8 | 2,080.07 | 36.44 | 500 |
| Li (lithium) | Trace. | | | 500 |
| $NH_4$ (ammonium) | .085 | | | 500 |
| Oxygen to form $Fe_2O_3$ | .10 | | | |
| Total | 2,326.7382 | 9,560.71 | 100.00 | |
| Free ammonia | .08 | | | |
| Albuminoid ammonia | .08 | | | |
| Nitrogen as nitrates | 2.00 | | | |
| Nitrogen as nitrites | .001 | | | |

### HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.252 | 0.01 |
| LiCl (lithium chlorid) | Trace. | |
| KCl (potassium chlorid) | 6.9 | .30 |
| NaCl (sodium chlorid) | 1,948.0 | 83.71 |
| $Na_2SO_4$ (sodium sulphate) | 57.4 | 2.47 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | |
| $NaNO_3$ (sodium nitrate) | 12.13 | .52 |
| $NaNO_2$ (sodium nitrite) | .0048 | |
| $Na(HCO_3)$ (sodium bicarbonate) | 216.9 | 9.32 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 21.0 | .90 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 53.1 | 2.29 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .4 | .02 |
| $SiO_2$ (silica) | 10.6 | .46 |
| Total | 2,326.6868 | 100.00 |

## No. 1021.—*Champion water, Saratoga, N. Y.*

[Sodic and calcic muriated alkaline-saline (bromic) carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure.)—Carbon dioxid (free), 110.8; carbon dioxid (set free from bicarbonates on evaporating to dryness), 294.5.

| Formula and name. | Bureau of Chemistry. | Crook. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 12.3 | 12.01 | 0.18 | 3,000 |
| $SO_4$ (sulphuric acid radicle) | 20.0 | 2.37 | .29 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 1,604.3 | 6,053.38 | 23.63 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | | | 100 |
| $NO_2$ (nitrous acid radicle) | None. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | .10 | | 900 |
| $BO_2$ (metaboric acid radicle) | (*a*) | | | 500 |
| $As_4$ (arsenic acid radicle) | None. | | | 500 |
| Cl (chlorin) | 2,799.1 | 7,635.70 | 41.24 | 100 |
| Br (bromin) | 13.5 | 47.70 | .20 | 250 |
| I (iodin) | .15 | 3.32 | | 500 |
| Fe (iron) | | 3.51 | | 1,000 |
| Fe, Al (iron and aluminum) | .8 | | .01 | 250 |
| $Al_2O_3$ (alumina) | | 7.89 | | |
| Mn (manganese) | Trace. | | | 300 |
| Ca (calcium) | 348.3 | 961.70 | 5.13 | 250 |
| Ba (barium) | 6.3 | 18.86 | .09 | |
| Sr (strontium) | | .57 | | |
| Mg (magnesium) | 81.1 | 546.75 | 1.19 | 250 |
| K (potassium) | 60.0 | 365.54 | .88 | 500 |
| Na (sodium) | 1,839.9 | 4,836.94 | 27.10 | 500 |
| Li (lithium) | .9 | 11.03 | .01 | 500 |
| $NH_4$ (ammonium) | 3.13 | | .05 | 100 |
| Oxygen to form $Fe_2O_3$ | .4 | | | |
| Total | 6,790.18 | 20,507.37 | 100.00 | |
| Free ammonia | 2.96 | | | |
| Albuminoid ammonia | 0.05 | | | |
| Nitrogen as nitrates | Trace. | | | |
| Nitrogen as nitrites | None. | | | |

(*a*) Small amount.

### HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 9.29 | 0.14 |
| LiCl (lithium chlorid) | 5.4 | .08 |
| KCl (potassium chlorid) | 101.8 | 1.50 |
| NaCl (sodium chlorid) | 4,521.6 | 66.60 |
| KBr (potassium bromid) | 20.0 | .29 |
| KI (potassium iodid) | .2 | |
| $Na_2SO_4$ (sodium sulphate) | 29.6 | .44 |
| $NaBO_2$ (sodium metaborate) | (*a*) | |
| $NaNO_3$ (sodium nitrate) | Trace. | |
| $Na(HCO_3)$ sodium bicarbonate) | 177.9 | 2.62 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 488.3 | 7.19 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 1,410.6 | 20.78 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 11.9 | .18 |
| $Sr(HCO_3)_2$ (strontium bicarbonate) | Trace. | |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 1.2 | |
| $Mn_3O_4$ (mangano-manganic oxid) | Trace. | |
| $SiO_2$ (silica) | 12.3 | .18 |
| Total | 6,790.09 | 100.00 |

(*a*) Small amount.

No. 1022.—*Allouez magnesia water, Green Bay, Wis.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 4.9; carbon dioxid (set free from bicarbonates on evaporating to dryness), 66.2.

| Formula and name. | Bureau of Chemistry. | Crook. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 21.1 | 33.80 | 3.22 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 58.8 | 41.56 | 8.97 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 360.3 | 715.24 | 54.92 | 100 |
| $NO_3$ (nitric acid radicle) | 26.57 | ..... | 4.05 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | Trace. | ..... | ..... | 800 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 31.0 | 44.30 | 4.73 | 200 |
| Br (bromin) | None. | ..... | ..... | 500 |
| I (iodin) | None. | ..... | ..... | 500 |
| Fe (iron) | ..... | .32 | ..... | ..... |
| Fe, Al (iron and aluminum) | .8 | ..... | .12 | 500 |
| $Al_2O_3$ (alumina) | ..... | 2.92 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 400 |
| Ca (calcium) | 87.4 | 105.15 | 13.33 | 500 |
| Mg (magnesium) | 43.4 | 77.62 | 6.62 | 500 |
| K (potassium) | 1.7 | .92 | .26 | 1,000 |
| Na (sodium) | 20.8 | 47.98 | 3.17 | 1,000 |
| Li (lithium) | Trace. | ..... | ..... | 1,000 |
| $NH_4$ (ammonium) | .01 | ..... | ..... | 500 |
| Oxygen to form $Fe_2O_3$ and $SiO_3$ | 4.00 | ..... | .61 | ..... |
| Total | 655.88 | 1,069.81 | 100.00 | ..... |
| Free ammonia | .01 | ..... | ..... | ..... |
| Albuminoid ammonia | .04 | ..... | ..... | ..... |
| Nitrogen as nitrates | 6.0 | ..... | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... | ..... |
| Oxygen required | .800 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.03 | ..... |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 3.2 | 0.49 |
| NaCl (sodium chlorid) | 27.7 | 4.22 |
| $MgCl_2$ (magnesium chlorid) | 17.1 | 2.61 |
| $MgSO_4$ (magnesium sulphate) | 73.7 | 11.24 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | ..... |
| $NaNo_3$ (sodium nitrate) | 36.43 | 5.55 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 145.1 | 22.13 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 317.8 | 48.46 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 1.2 | .18 |
| $CaSiO_3$ (calcium silicate) | 25.9 | 3.95 |
| $SiO_2$ (silica) | 7.7 | 1.17 |
| Total | 655.86 | 100.00 |

No. 1023.—*Mount Clemens water, Mount Clemens, Mich.*

[Sodic muriated saline (lithic, bromic, iodic) sulphureted.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Hydrogen sulphid, 14.3.

| Formula and name. | Bureau of Chemistry. | Crook. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 11.0 | 473.4 | 0.01 | 100 |
| $SO_4$ (sulphuric acid radicle) | 548.8 | 1,217.6 | .43 | 33⅓ |
| $HCO_3$ (bicarbonic acid radicle) | 163.5 | ..... | .13 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 52.2 | ..... | ..... |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 100 |
| $BO_3$ (metaboric acid radicle) | (*a*) | ..... | ..... | 100 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 100 |
| Cl (chlorin) | 79,936.1 | 142,328.5 | 62.14 | 100 |
| Br (bromin) | 487.4 | 94.9 | .38 | 1,000 |
| I (iodin) | 2.3 | 1.1 | ..... | 1,000 |
| Fe (iron) | ..... | 62.5 | ..... | ..... |
| Fe, Al (iron and aluminum) | 3.0 | ..... | ..... | 100 |
| $Al_2O_3$ (alumina) | ..... | 505.7 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 50 |
| Ca (calcium) | 12,571.6 | 6,295.5 | 9.77 | 10 |
| Mg (magnesium) | 3,784.5 | 2,857.2 | 2.94 | 10 |
| K (potassium) | 1,133.7 | ..... | .88 | 33⅓ |
| Na (sodium) | 29,988.2 | 80,319.6 | 23.31 | 33⅓ |
| Li (lithium) | 17.5 | ..... | .01 | 33⅓ |
| $NH_4$ (ammonium) | ..... | ..... | ..... | ..... |
| Oxygen to form $Fe_2O_3$ | 1.2 | ..... | ..... | ..... |
| Total | 128,648.8 | 234,208.2 | 100.00 | ..... |

(*a*) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| LiCl (lithium chlorid) | 105.9 | 0.08 |
| KCl (potassium chlorid) | 1,707.1 | 1.33 |
| NaCl (sodium chlorid) | 76,108.8 | 59.17 |
| $MgCl_2$ (magnesium chlorid) | 14,948.8 | 11.62 |
| $CaCl_2$ (calcium chlorid) | 34,039.9 | 26.46 |
| KBr (potassium bromid) | 725.0 | .56 |
| KI (potassium iodid) | 3.0 | ..... |
| $CaSO_4$ (calcium sulphate) | 777.6 | .60 |
| $NaBO_2$ (sodium metaborate) | (*a*) | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 217.5 | .17 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 4.2 | ..... |
| $SiO_2$ (silica) | 11.0 | .01 |
| Total | 128,648.8 | 100.00 |

(*a*) Small amount.

No. 1024.—*Berry Hill dyspepsia water, Elkwood, Va.*

[Calcic sulphated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 1.4; carbon dioxid (set free from bicarbonates on evaporating to dryness), 27.7.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 27.6 | 17.0 | 1.04 | 3,000 |
| $SO_4$ (sulphuric acid radicle) | 1,686.0 | 1,846.5 | 63.78 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 151.4 | ..... | 5.73 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 108.8 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | Trace. | ..... | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | .009 | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | .5 | ..... | 900 |
| $PO_2$ (hypophosphorous acid radicle) | None. | 8.9 | ..... | 900 |
| $BO_2$ (metaboric acid radicle) | (*a*) | ..... | ..... | 600 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Fl (fluorin) | ..... | .3 | ..... | ..... |
| Cl (chlorin) | 26.0 | 25.0 | .99 | 100 |
| Br (bromin) | Trace. | ..... | ..... | 600 |
| I (iodin) | Trace. | .03 | ..... | 600 |
| Fe (iron) | ..... | 1.8 | ..... | ..... |
| Fe, Al (iron and aluminum) | 1.5 | ..... | .06 | 500 |
| Al (aluminum) | ..... | 30.0 | ..... | ..... |
| Mn (manganese) | Trace. | .05 | ..... | 300 |
| Ca (calcium) | 524.7 | 520.4 | 19.86 | 500 |
| Mg (magnesium) | 58.8 | 61.2 | 2.22 | 500 |
| Sr (strontium) | None. | 5.4 | ..... | 2,000 |
| K (potassium) | 3.4 | 7.4 | .13 | 500 |
| Na (sodium) | 163.7 | 195.2 | 6.19 | 500 |
| Li (lithium) | Trace. | .2 | ..... | 500 |
| $NH_4$ (ammonium) | .053 | ..... | ..... | 500 |
| Total | 2,643.162 | 2,828.68 | 100.00 | ..... |
| Free ammonia | .05 | ..... | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... | ..... |
| Nitrogen as nitrates | Trace. | ..... | ..... | ..... |
| Nitrogen as nitrites | .003 | ..... | ..... | ..... |
| Oxygen required | .754 | ..... | ..... | ..... |

(*a*) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.157 | ..... |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 6.5 | 0.25 |
| NaCl (sodium chlorid) | 37.6 | 1.42 |
| KBr (potassium bromid) | Trace. | ..... |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 459.6 | 17.39 |
| $MgSO_4$ (magnesium sulphate) | 291.5 | 11.03 |
| $CaSO_4$ (calcium sulphate) | 1,618.7 | 61.25 |
| $NaBO_2$ (sodium metaborate) | (*a*) | ..... |
| $NaNO_3$ (sodium nitrate) | Trace. | ..... |
| $NaNO_2$ (sodium nitrite) | .014 | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 197.0 | 7.45 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 4.5 | .17 |
| $Mn_3O_4$ (mangano-manganic oxid) | Trace. | ..... |
| $SiO_2$ (silica) | 27.6 | 1.04 |
| Total | 2,643.171 | 100.00 |

(*a*) Small amount.

No. 1025.—*Gitche Crystal Spring water.*

[Sodic and potassic, muriated alkaline-saline (silicious).]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 4.4; carbon dioxid (set free from bicarbonates on evaporating to dryness), 1.1.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 6.7 | | 30.11 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 1.2 | | 5.39 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 6.3 | | 28.31 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | | | 100 |
| $NO_2$ (nitrous acid radicle) | None. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | | | 1,000 |
| $BO_2$ (metaboric acid radicle) | Trace. | | | 600 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 600 |
| Cl (chlorin) | 3.0 | | 13.48 | 1,000 |
| Br (bromin) | None. | | | 600 |
| I (iodin) | None. | | | 600 |
| Fe\| Al\| (iron and aluminum) | .2 | | .90 | 1,000 |
| Mn (manganese) | None. | | | 500 |
| Ca (calcium) | .4 | | 1.80 | 1,000 |
| Mg (magnesium) | .4 | | 1.80 | 1,000 |
| K (potassium) | 1.4 | | 6.29 | 1,000 |
| Na (sodium) | 2.6 | | 11.68 | 1,000 |
| Li (lithium) | Trace. | | | 1,000 |
| $NH_4$ (ammonium) | .053 | | .24 | 500 |
| Total | 22.253 | | 100.00 | |
| Free ammonia | .05 | .00 | | |
| Albuminoid ammonia | .04 | .01 | | |
| Nitrogen as nitrates | Trace. | 1.00 | | |
| Nitrogen as nitrites | None. | None. | | |
| Oxygen required | .8 | .40 | | |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.157 | 0.71 |
| LiCl (lithium chlorid) | Trace. | |
| KCl (potassium chlorid) | 2.7 | 12.13 |
| NaCl (sodium chlorid) | 2.6 | 11.68 |
| $Na_2SO_4$ (sodium sulphate) | 1.8 | 8.09 |
| $NaBO_2$ (sodium metaborate) | Trace. | |
| $NaNO_3$ (sodium nitrate) | Trace. | |
| $Na(HCO_3)$ (sodium bicarbonate) | 3.7 | 16.62 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 2.4 | 10.78 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 1.6 | 7.19 |
| $Fe(HCO^6)_2$ (ferrous bicarbonate) | .6 | 2.70 |
| $SiO_2$ (silica) | 6.7 | 30.10 |
| Total | 22.257 | 100.00 |

No. 1026.—*Great Bear water, Fulton, N. Y.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure.—Carbon dioxid (free), 2.4; carbon dioxid (set free from bicarbonates on evaporating to dryness), 21.7.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 9.7 | | 4.41 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 8.8 | 8.7 | 4.00 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 118.0 | | 53.64 | 100 |
| $CO_3$ (carbonic acid radicle) | | 51.1 | | |
| $NO_3$ (nitric acid radicle) | 8.86 | | 4.03 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | | | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | | | 600 |
| $AsO_4$ (arsenic acid radicle) | None. | | | 600 |
| Cl (chlorin) | 21.5 | 6.0 | 9.77 | 200 |
| Br (bromin) | None. | | | 600 |
| I (iodin) | None. | | | 600 |
| Fe, Al (iron and aluminum) | .3 | | .14 | 1,000 |
| Mn (manganese) | None. | | | 500 |
| Ca (calcium) | 30.9 | 27.6 | 14.05 | 1,000 |
| Mg (magnesium) | 10.0 | 8.4 | 4.55 | 1,000 |
| K (potassium) | 1.7 | | .77 | 1,000 |
| Na (sodium) | 10.2 | | 4.64 | 1,000 |
| Li (lithium) | Trace. | | | 1,000 |
| $NH_4$ (ammonium) | .01 | | | 500 |
| Total | 219.97 | | 100.00 | |
| Free ammonia | .01 | .002 | | |
| Albuminoid ammonia | .04 | .01 | | |
| Nitrogen as nitrates | 2.00 | .80 | | |
| Nitrogen as nitrites | Trace. | None. | | |
| Oxygen required | .3 | .25 | | |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.03 | 0.01 |
| LiCl (lithium chlorid) | Trace. | |
| KCl (potassium chlorid) | 3.2 | 1.45 |
| NaCl (sodium chlorid) | 17.5 | 7.96 |
| $MgCl_2$ (magnesium chlorid) | 12.6 | 5.73 |
| $MgSO_4$ (magnesium sulphate) | 11.0 | 5.00 |
| $NaNO_3$ (sodium nitrate) | 12.15 | 5.52 |
| $NaNO_2$ (sodium nitrite) | Trace. | |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 27.7 | 12.60 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 125.1 | 56.87 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 1.0 | .45 |
| $SiO_2$ (silica) | 9.7 | 4.41 |
| Total | 219.98 | 100.00 |

No. 1116.—*Londonderry lithia water, Londonderry, N. H.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 2.3; carbon dioxid (set free from bicarbonates on evaporating to dryness), 7.1.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 17.0 | 6.5 | 18.76 | 5,000 |
| $SO_4$ (sulphuric acid radicle) | 7.6 | 145.27 | 8.38 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 39.1 | 10.10 | 43.15 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 237.90 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | 2.92 | ..... | 3.22 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 1,000 |
| Cl (chlorin) | 2.9 | 213.40 | 3.20 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | None. | ..... | ..... | 1,000 |
| $Fe_2O_3$ (ferric oxid) | ..... | 4.50 | ..... | ..... |
| Fe, Al (iron and aluminum) | .3 | ..... | .33 | 1,000 |
| Mn (manganese) | None. | ..... | ..... | 1,000 |
| Ca (calcium) | 9.5 | 3.33 | 10.48 | 1,000 |
| Mg (magnesium) | 1.2 | 12.20 | 1.32 | 1,000 |
| K (potassium) | 2.9 | 7.00 | 3.20 | 500 |
| Na (sodium) | 6.9 | 385.80 | 7.61 | 500 |
| Li (lithium) | Trace. | 10.30 | ..... | 500 |
| $NH_4$ (ammonium) | .016 | ..... | .02 | 500 |
| Oxygen to form $Fe_2O_3$ and $SiO_3$ | .3 | ..... | .33 | ..... |
| Total | 90.636 | 1,186.30 | 100.00 | ..... |
| Free ammonia | .015 | ..... | ..... | ..... |
| Albuminoid ammonia | .075 | ..... | ..... | ..... |
| Nitrogen as nitrates | .66 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |
| Oxygen required | .90 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.048 | 0.05 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 5.5 | 6.07 |
| NaCl (sodium chlorid) | .5 | .55 |
| $Na_2SO_4$ (sodium sulphate) | 11.2 | 12.35 |
| $NaNO_3$ (sodium nitrate) | 4.0 | 4.41 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 7.3 | 8.05 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 7.2 | 7.94 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 36.9 | 40.72 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .4 | .44 |
| $CaSiO_3$ (calcium silicate) | 1.2 | 1.32 |
| $SiO_2$ (silica) | 16.4 | 18.10 |
| Total | 90.648 | 100.00 |

No. 1117.—*White Rock lithia water, Waukesha, Wis.*

[Sodic and calcic muriated alkaline-saline (lithic) carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), supersaturated; carbon dioxid (set free from bicarbonates on evaporating to dryness), 64.4.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 12.4 | 10.0 | 1.03 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 39.6. | 42.3 | 3.29 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 351.2 | 217.5 | 29.18 | 100 |
| $NO_3$ (nitric acid radicle) | 4.43 | 2.1 | .37 | 100 |
| $NO_2$ (nitrous acid radicle) | .016 | None. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | Trace. | ..... | 800 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 434.0 | 407.0 | 36.06 | 100 |
| Br (bromin) | None. | ..... | ..... | 500 |
| I (iodin) | None. | ..... | ..... | 500 |
| Fe (iron) | ..... | .1 | ..... | ..... |
| Fe, Al (iron and aluminum) | .4 | ..... | .03 | 1,000 |
| $Al_2O_3$ (alumina) | ..... | .5 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 800 |
| Ca (calcium) | 80.9 | 51.2 | 6.72 | 1,000 |
| Mg (magnesium) | 37.5 | 35.2 | 3.12 | 1,000 |
| K (potassium) | 3.0 | 3.4 | .25 | 500 |
| Na (sodium) | 227.3 | 115.3 | 18.89 | 500 |
| Li (lithium) | 12.6 | 38.1 | 1.05 | 500 |
| $NH_4$ (ammonium) | .042 | ..... | ..... | 500 |
| Oxygen to form $Fe_2O_3$ | .17 | ..... | .01 | ..... |
| Total | 1,203.558 | 922.7 | 100.00 | ..... |
| Free ammonia | .04 | ..... | ..... | ..... |
| Albuminoid ammonia | .09 | ..... | ..... | ..... |
| Nitrogen as nitrates | 1.00 | ..... | ..... | ..... |
| Nitrogen as nitrites | .005 | ..... | ..... | ..... |
| Oxygen required | .5 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.125 | 0.01 |
| LiCl (lithium chlorid) | 76.4 | 6.35 |
| KCl (potassium chlorid) | 5.7 | .47 |
| NaCl (sodium chlorid) | 573.6 | 47.65 |
| $MgCl_2$ (magnesium chlorid) | 26.2 | 2.18 |
| $MgSO_4$ (magnesium sulphate) | 49.6 | 4.12 |
| $NaNO_3$ (sodium nitrate) | 6.07 | .50 |
| $NaNO_2$ (sodium nitrite) | .024 | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 125.2 | 10.41 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 327.7 | 27.23 |
| $FeO_3$, $Al_2O_3$ (ferric oxid and alumina) | .57 | .05 |
| $SiO_2$ (silica) | 12.4 | 1.03 |
| Total | 1,203.589 | 100.00 |

## No. 1119.—*Crockett arsenic lithia water, Shawsville, Va.*

[Calcic bicarbonated alkaline (arsenic).]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 1.4; carbon dioxid (set free from bicarbonates on evaporating to dryness), 36.6.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 48.3 | 23.38 | 10.45 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 100.8 | 102.85 | 21.82 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 199.8 | ..... | 43.25 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 76.82 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | .22 | .037 | .05 | 100 |
| $NO_2$ (nitrous acid radicle) | (*a*) | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | .03 | ..... | 800 |
| $BO_2$ (metaboric acid radicle) | (*b*) | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | .24 | .18 | .05 | 500 |
| Cl (chlorin) | 5.00 | 12.78 | 1.08 | 100 |
| Br (bromin) | None. | .14 | ..... | 1,000 |
| I (iodin) | Trace. | .08 | ..... | 1,000 |
| Fe (iron) | ..... | .28 | ..... | ..... |
| Fe, Al (iron and aluminum) | .7 | ..... | .15 | 1,000 |
| Al (aluminum) | ..... | .39 | ..... | ..... |
| Ca (calcium) | 60.4 | 51.84 | 13.07 | 1,000 |
| Ba (barium) | Trace. | .10 | ..... | 3,000 |
| Sr (strontium) | Trace. | .90 | ..... | 3,000 |
| Mg (magnesium) | 21.0 | 16.30 | 4.54 | 1,000 |
| K (potassium) | 6.7 | 9.60 | 1.45 | 1,000 |
| Na (sodium) | 17.4 | 18.76 | 3.77 | 1,000 |
| Li (lithium) | .02 | .23 | ..... | 1,000 |
| H to form di-sodium arsenate | .002 | ..... | ..... | ..... |
| $NH_4$ (ammonium) | .01 | .013 | ..... | 500 |
| Oxygen to form $Fe_2O_3$ and $SiO_3$ | 1.50 | ..... | .32 | ..... |
| Total | 462.092 | 314.710 | 100.00 | ..... |
| Free ammonia | .01 | ..... | ..... | ..... |
| Albuminoid ammonia | .05 | ..... | ..... | ..... |
| Nitrogen as nitrates | .05 | ..... | ..... | ..... |
| Nitrogen as nitrites | (*a*) | ..... | ..... | ..... |
| Oxygen required | .30 | ..... | ..... | ..... |

*a* Heavy trace. *b* Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.03 | ..... |
| $LiCl$ (lithium chlorid) | .12 | 0.03 |
| $KCl$ (potassium chlorid) | 10.3 | 2.23 |
| $KI$ (potassium iodid) | Trace. | ..... |
| $K_2SO_4$ (potassium sulphate) | 2.9 | .63 |
| $Na_2SO_4$ (sodium sulphate) | 53.3 | 11.53 |
| $MgSO_4$ (magnesium sulphate) | 79.2 | 17.14 |
| $NaBO_2$ (sodium metaborate) | (*a*) | ..... |
| $Na_2HAsO_4$ (di-sodium arsenate) | .322 | .07 |
| $NaNO_3$ (sodium nitrate) | .3 | .06 |
| $NaNO_2$ (sodium nitrite) | (*b*) | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 30.0 | 6.49 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 232.1 | 50.22 |
| $FeO_3$, $Al_2O_3$ (ferric oxid and alumina) | 1.0 | .22 |
| $CaSiO_3$ (calcium silicate) | 9.0 | 1.95 |
| $SiO_2$ (silica) | 43.6 | 9.43 |
| Total | 462.172 | 100.00 |

*a* Small amount. *b* Heavy trace.

No. 1120.—*Pluto concentrated water, French Lick, Ind.*

[Sodic sulphated saline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (set free from bicarbonates on evaporating to dryness), 40.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| Silica, iron, and alumina earth | ..... | 13.0 | ..... | ..... |
| $SiO_2$ (silica) | 29.2 | ..... | 0.03 | 1,000 |
| $SO_4$ (sulphuric acid radicle) | 68,394.3 | 49,420.2 | 69.41 | 100 |
| $HCO_3$ (bicarbonic acid radicle) | 217.5 | ..... | .22 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 100 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 100 |
| Cl (chlorin) | 1,446.0 | 9,036.9 | 1.47 | 100 |
| Br (bromin) | None. | ..... | ..... | 100 |
| I (iodin) | Trace. | ..... | ..... | 100 |
| Fe, Al (iron and aluminum) | 3.5 | ..... | ..... | 100 |
| Mn (manganese) | None. | ..... | ..... | 100 |
| Ca (calcium) | 393.6 | 2,470.6 | .40 | 100 |
| Mg (magnesium) | 6,099.4 | 4,847.9 | 6.19 | 100 |
| K (potassium) | 283.2 | ..... | .29 | 100 |
| Na (sodium) | 21,672.4 | 17,524.4 | 21.99 | 100 |
| Li (lithium) | (a) | ..... | ..... | 100 |
| Oxygen to form $Fe_2O_3$ | 1.5 | ..... | ..... | ..... |
| Total | 98,540.6 | 83,313.0 | 100.00 | ..... |

[a] Heavy trace.

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| LiCl (lithium chlorid) | (a) | ..... |
| KCl (potassium chlorid) | 539.9 | 0.55 |
| NaCl (sodium chlorid) | 1,960.9 | 1.99 |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 64,425.2 | 65.38 |
| $MgSO_4$ (magnesium sulphate) | 30,195.8 | 30.65 |
| $CaSO_4$ (calcium sulphate) | 1,095.8 | 1.11 |
| $NaNO_2$ (sodium nitrate) | Trace. | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 288.8 | .29 |
| $FeO_3$, $Al_2O_3$ (ferric oxid and alumina) | 5.0 | ..... |
| $SiO_2$ (silica) | 29.2 | .03 |
| Total | 98,540.6 | 100.00 |

[a] Heavy trace.

No. 1121.—*Red Raven aperient water, Harmarville, Pa.*

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), supersaturated; carbon dioxid (set free from bicarbonates on evaporating to dryness), 45.5.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 63.6 | 0.23 | 1,000 |
| $SO_4$ (sulphuric acid radicle) | 667.2 | 2.39 | 100 |
| $HCO_3$ (bicarbonic acid radicle) | 248.0 | .89 | 100 |
| $PO_4$ (phosphoric acid radicle) | 17,615.0 | 63.17 | 100 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | 100 |
| Cl (chlorin) | 100.8 | .36 | 100 |
| Br (bromin) | None. | ..... | 100 |
| I (iodin) | None. | ..... | 100 |
| Fe, Al (iron and aluminum) | None. | ..... | 200 |
| Ca (calcium) | None. | ..... | 200 |
| Mg (magnesium) | None. | ..... | 200 |
| K (potassium) | None. | ..... | 100 |
| Na (sodium) | 9,008.0 | 32.30 | 100 |
| Li (lithium) | None. | ..... | 100 |
| Hydrogen to form $Na_2HPO_4$ | 185.4 | .66 | ..... |
| Total | 27,888.0 | 100.00 | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| NaCl (sodium chlorid) | 166.1 | 0.60 |
| $Na_2SO_4$ (sodium sulphate) | 986.9 | 3.55 |
| $Na_2HPO_4$ (di-sodium phosphate) | 26,329.8 | 94.40 |
| $Na(HCO_3)$ (sodium bicarbonate) | 341.5 | 1.22 |
| $SiO_2$ (silica) | 63.6 | .23 |
| Total | 27,887.9 | 100.00 |

No. 1122.—*Augusta White Lithia water, Augusta Springs, Va.*

[Sodic and calcic bicarbonated alkaline (silicious).]

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 20.1 | 9.386 | 31.85 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 2.0 | 3.231 | 3.17 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 27.4 | ..... | 43.43 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 28.219 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | .33 | .620 | .52 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | Trace. | .015 | ..... | 800 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 1.9 | .653 | 3.01 | 500 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | Trace. | ..... | ..... | 1,000 |
| Fe (iron) | ..... | .467 | ..... | ..... |
| Fe, Al (iron and aluminum) | .5 | ..... | .79 | 1,000 |
| Al (aluminum) | ..... | .061 | ..... | ..... |
| Mn (manganese) | None. | .016 | ..... | 1,000 |
| Ca (calcium) | 3.9 | 15.956 | 6.18 | 1,000 |
| Mg (magnesium) | 1.4 | 1.550 | 2.22 | 1,000 |
| K (potassium) | 1.3 | .882 | 2.06 | 1,000 |
| Na (sodium) | 4.2 | 1.541 | 6.66 | 1,000 |
| Li (lithium) | .05 | .021 | .08 | 1,000 |
| $NH_4$ (ammonium) | .021 | .004 | .03 | 500 |
| Total | 63.101 | 62.622 | 100.00 | ..... |
| Free ammonia | .02 | ..... | ..... | ..... |
| Albuminoid ammonia | .05 | ..... | ..... | ..... |
| Nitrogen as nitrates | .075 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |
| Oxygen required | .9 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.063 | 0.10 |
| LiCl (lithium chlorid) | .30 | .48 |
| KCl (potassium chlorid) | 2.5 | 3.96 |
| NaCl (sodium chlorid) | .7 | 1.11 |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 3.0 | 4.75 |
| $NaBO_2$ (sodium metaborate) | Trace. | ..... |
| $Ca_3(PO_4)_2$ (calcium phosphate) | Trace. | ..... |
| $NaNO_3$ (sodium nitrate) | .45 | .71 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 10.2 | 16.16 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 8.4 | 13.31 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 15.8 | 25.04 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 1.6 | 2.54 |
| $SiO_2$ (silica) | 20.1 | 31.84 |
| Total | 63.113 | 100.00 |

## No. 1123.—*Bear Lithia water, Bear Lithia, Va.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 6.8; carbon dioxid (set free from bicarbonates on evaporating to dryness), 21.2.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 15.5 | 10.14 | 9.00 | 4,000 |
| $SO_4$ (sulphuric acid radicle) | 2.9 | 8.70 | 1.68 | 1,000 |
| $HCO_3$ (bicarbonic acid radicle) | 115.3 | ..... | 66.96 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 66.66 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | .89 | ..... | .52 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 1,000 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 1,000 |
| Cl (chlorin) | 2.2 | 2.05 | 1.28 | 250 |
| Br (bromin) | None. | ..... | ..... | 1,000 |
| I (iodin) | Trace. | ..... | ..... | 1,000 |
| Fe (iron) | ..... | .90 | ..... | ..... |
| Fe, Al (iron and aluminum) | .14 | ..... | .08 | 1,000 |
| $Al_2O_3$ (alumina) | ..... | .26 | ..... | ..... |
| Mn (manganese) | None. | ..... | ..... | 1,000 |
| Ca (calcium) | 18.2 | 24.13 | 10.57 | 1,000 |
| Mg (magnesium) | 10.2 | 12.54 | 5.92 | 1,000 |
| K (potassium) | 1.6 | 2.61 | .93 | 1,000 |
| Na (sodium) | 5.2 | 2.73 | 3.02 | 1,000 |
| Li (lithium) | Trace. | .03 | ..... | 1,000 |
| $NH_4$ (ammonium) | .021 | ..... | .01 | 500 |
| Oxygen to form $Fe_2O_3$ | .06 | ..... | .03 | ..... |
| Total | 172.211 | 130.75 | 100.00 | ..... |
| Free ammonia | .02 | ..... | ..... | ..... |
| Albuminoid ammonia | .04 | ..... | ..... | ..... |
| Nitrogen as nitrates | .20 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |
| Oxygen required | .25 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.063 | 0.04 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 3.1 | 1.80 |
| NaCl (sodium chlorid) | 1.2 | .70 |
| Ki (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 4.3 | 2.50 |
| $NaNO_3$ (sodium nitrate) | 1.22 | .71 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 11.0 | 6.38 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 62.0 | 35.98 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 73.7 | 42.77 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | .2 | .12 |
| $SiO_2$ (silica) | 15.5 | 9.00 |
| Total | 172,283 | 100.00 |

No. 1220.—*Sheboygan water, Sheboygan, Wis.*

[Sodic and calcic muriated alkaline-saline, carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), supersaturated; carbon dioxid (set free from bicarbonates on evaporating to dryness), 121.2.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 113.1 | | 0.36 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 551.4 | | 15.12 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 660.1 | | 18.10 | 100 |
| $NO_3$ (nitric acid radicle) | 2.21 | | .06 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | (*a*) | | | 500 |
| $BO_2$ (metaboric acid radicle) | (*b*) | | | 333½ |
| $AsO_4$ (arsenic acid radicle) | None. | | | 333½ |
| Cl (chlorin) | 1,210.0 | | 33.18 | 10 |
| Br (bromin) | Trace. | | | 1,000 |
| I (iodin) | (*c*) | | | 1,000 |
| Fe, Al (iron and aluminum) | 1.1 | | .03 | 500 |
| Mn (manganese) | None. | | | 250 |
| Ca (calcium) | 244.7 | | 6.71 | 500 |
| Mg (magnesium) | 64.7 | | 1.77 | 500 |
| K (potassium) | 11.6 | | .32 | 500 |
| Na (sodium) | 887.8 | | 24.35 | 500 |
| Li (lithium) | .2 | | | 500 |
| $NH_4$ (ammonium) | .132 | | | 500 |
| Oxygen to form $Fe_2O_3$ | .103 | | | |
| Total | 3,647.142 | | 100.00 | |
| Free ammonia | .125 | 0.00 | | |
| Albuminoid ammonia | .075 | .013 | | |
| Nitrogen as nitrates | .50 | .00 | | |
| Nitrogen as nitrites | Trace. | .00 | | |

*a* Heavy trace. *b* Minute trace. *c* Faint trace.

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.392 | 0.01 |
| LiCl (lithium chlorid) | 1.2 | .03 |
| KCl (potassium chlorid) | 22.1 | .61 |
| NaCl (sodium chlorid) | 1,976.7 | 54.20 |
| KBr (potassium bromid) | Trace. | |
| KI (potassium iodid) | (*a*) | |
| $Na_2SO_4$ (sodium sulphate) | 334.9 | 9.18 |
| $MgSO_4$ (magnesium sulphate) | 320.3 | 8.78 |
| $CaSO_4$ (calcium sulphate) | 98.3 | 2.70 |
| $NaBO_2$ (sodium metaborate) | Trace. | |
| $NaNO_3$ (sodium nitrate) | 3.03 | .08 |
| $NaNO_2$ (sodium nitrite) | Trace. | |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 874.0 | 23.96 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 2.8 | .08 |
| $FeO_3$, $Al_2O_3$ (ferric oxid and alumina) | .3 | .01 |
| $SiO_2$ (silica) | 13.1 | .36 |
| Total | 3,647.122 | 100.00 |

*a* Faint trace.

## No. 1221.—*Manitou table water, Manitou, Colo.*

[Sodic and calcic bicarbonated alkaline carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), supersaturated; carbon dioxid (set free from bicarbonates on evaporating to dryness), 489.1.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 47.2 | 42.71 | 1.09 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 219.2 | 218.63 | 5.04 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 2,664.6 | ..... | 61.34 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 1,319.76 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | None. | ..... | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | (*a*) | ..... | ..... | 333⅓ |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 333⅓ |
| Cl (chlorin) | 250.0 | 248.81 | 5.75 | 100 |
| Br (bromin) | (*b*) | ..... | ..... | 1,000 |
| I (iodin) | None. | ..... | ..... | 1,000 |
| $Fe_2O_3$ (ferric oxid) | ..... | .34 | ..... | ..... |
| Fe, Al (iron and aluminum) | 1.8 | ..... | .04 | 500 |
| $Al_2O_3$ (alumina) | ..... | 1.20 | ..... | ..... |
| Mn (manganese) | 1.7 | ..... | .04 | 250 |
| Ca (calcium) | 457.9 | 473.88 | 10.54 | 500 |
| Mg (magnesium) | 79.2 | 81.73 | 1.82 | 500 |
| K (potassium) | 71.3 | 82.10 | 1.64 | 500 |
| Na (sodium) | 551.0 | 520.75 | 12.68 | 500 |
| Li (lithium) | .23 | 2.30 | ..... | 500 |
| $NH_4$ (ammonium) | .05 | ..... | ..... | 500 |
| Oxygen to form $Mn_3O_4$ | .7 | ..... | .02 | ..... |
| Total | 4,344.88 | 2,992.21 | 100.00 | ..... |
| Free ammonia | .05 | ..... | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... | ..... |
| Oxygen required | 1.0 | ..... | ..... | ..... |

*a* Small amount. *b* Faint trace.

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.15 | ..... |
| LiCl (lithium chlorid) | 1.38 | 0.03 |
| KCl (potassium chlorid) | 136.10 | 3.13 |
| NaCl (sodium chlorid) | 303.20 | 6.98 |
| KBr (potassium bromid) | (*a*) | ..... |
| $Na_2SO_4$ (sodium sulphate) | 324.20 | 7.46 |
| $NaBO_2$ (sodium metaborate) | (*b*) | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 1,193.20 | 27.46 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 476.80 | 10.97 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 1,854.50 | 42.69 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 5.70 | .13 |
| $Mn_3O_4$ (mangano-manganic oxid) | 2.40 | .06 |
| $SiO_2$ (silica) | 47.2 | 1.09 |
| Total | 4,344.83 | 100.00 |

*a* Faint trace. *b* Small amount.

No. 1222.—*Rubino Healing Springs water, Healing Springs, Va.*

[Calcic bicarbonated alkaline.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure—Carbon dioxid (free), 21.3; carbon dioxid (set free from bicarbonates on evaporating to dryness), 87.3.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 27.9 | 20.51 | 3.44 | 3,000 |
| $SO_4$ (sulphuric acid radicle) | 101.8 | 132.74 | 12.54 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 475.4 | 527.26 | 58.56 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | | | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | | | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | | | 500 |
| $BO_2$ (metaboric acid radicle) | None. | | | 666 |
| $AsO_4$ (arsenic acid radicle) | (*a*) | | | 666 |
| Cl (chlorin) | 4.0 | 3.35 | .49 | 250 |
| Br (bromin) | None. | | | 1,000 |
| I (iodin) | None. | | | 1,000 |
| Fe, Al (iron and aluminum) | 1.3 | 2.60 | .16 | 500 |
| Mn (manganese) | None. | | | 250 |
| Ca (calcium) | 129.0 | 142.56 | 15.89 | 500 |
| Mg (magnesium) | 37.8 | 36.17 | 4.66 | 500 |
| K (potassium) | 14.3 | 18.05 | 1.76 | 500 |
| Na (sodium) | 15.1 | 17.54 | 1.86 | 500 |
| Li (lithium) | Trace. | .91 | | 500 |
| $NH_4$ (ammonium) | .026 | | | 200 |
| Oxygen to form $Fe_2O_3$ and $SiO_3$ | 5.2 | | .64 | |
| Total | 811.826 | 901.69 | 100.00 | |
| Free ammonia | .025 | | | |
| Albuminoid ammonia | .075 | | | |
| Nitrogen as nitrates | Trace. | | | |
| Nitrogen as nitrites | Trace. | | | |
| Oxygen required | .45 | | | |

*a* Minute trace.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.078 | 0.01 |
| LiCl (lithium chlorid) | Trace. | |
| KCl (potassium chlorid) | 8.2 | 1.01 |
| $Na_2SO_4$ (sodium sulphate) | 46.6 | 5.74 |
| $K_2SO_4$ (potassium sulphate) | 22.3 | 2.75 |
| $MgSO_4$ (magnesium sulphate) | 72.6 | 8.94 |
| $NaNO_3$ (sodium nitrate) | Trace. | |
| $NaNO_2$ (sodium nitrite) | Trace. | |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 139.7 | 17.21 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 476.6 | 58.71 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 2.0 | .25 |
| $CaSiO_3$ (calcium silicate) | 32.9 | 4.05 |
| $SiO_2$ (silica) | 10.8 | 1.33 |
| Total | 811.778 | 100.00 |

## No. 1223.—*Rockbridge alum water, Rockbridge Alum Springs, Va.*

[Aluminic sulphated acid (ferruginous).]

| Formula and name. | Bureau of Chemistry. | Advertised—parts per million.[a] | | | | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|---|---|---|
| | | 1. | 2. | 3. | 4. | | |
| | *Parts per million.* | | | | | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 46.8 | 60.8 | 63.4 | 53.6 | 75.2 | 10.04 | 3,000 |
| $H_2SO_4$ (sulphuric acid) | ..... | 55.5 | 65.6 | 35.0 | 52.6 | ..... | ..... |
| $SO_4$ (sulphuric acid radicle) | 339.0 | 513.0 | 766.9 | 792.3 | 1,234.2 | 72.70 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | None. | ..... | ..... | ..... | ..... | ..... | 100 |
| $NO_3$ (nitric acid radicle) | 1.33 | ..... | ..... | ..... | ..... | .29 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | ..... | ..... | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | .2 | 1.8 | 2.5 | .6 | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | ..... | ..... | ..... | $666\frac{2}{3}$ |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | ..... | ..... | ..... | $666\frac{2}{3}$ |
| Cl (chlorin) | 2.4 | .8 | 1.1 | 1.1 | 1.5 | .51 | 250 |
| Cu (copper) | ..... | .3 | .3 | .6 | .7 | ..... | ..... |
| Ni (nickel) | ..... | .4 | .9 | 1.6 | 1.5 | ..... | ..... |
| Br (bromin) | None. | ..... | ..... | ..... | ..... | ..... | 500 |
| Co (cobalt) | ..... | .2 | .1 | .5 | .5 | ..... | ..... |
| Zn (zinc) | ..... | .8 | 2.7 | 1.4 | 1.5 | ..... | ..... |
| I (iodin) | Trace. | ..... | ..... | ..... | ..... | ..... | 500 |
| Fe (iron) | 3.7 | 4.9 | 9.3 | 8.4 | 13.9 | .79 | 500 |
| Al (aluminum) | 53.2 | 82.8 | 115.4 | 119.0 | 196.0 | 11.41 | 500 |
| Mn (manganese) | .3 | 5.4 | .6 | 3.3 | 8.6 | .06 | 250 |
| Ca (calcium) | 4.1 | 8.9 | 17.4 | 14.3 | 12.0 | .88 | 500 |
| Mg (magnesium) | 6.8 | 3.0 | 19.2 | 21.9 | 25.2 | 1.46 | 500 |
| K (potassium) | 1.5 | 1.3 | 3.2 | 3.0 | 1.4 | .32 | 500 |
| Na (sodium) | 6.9 | .6 | .9 | .8 | 1.2 | 1.48 | 500 |
| Li (lithium) | Trace. | .04 | .04 | .04 | .07 | ..... | 500 |
| $NH_4$ (ammonium) | .173 | ..... | ..... | ..... | ..... | .04 | 500 |
| Oxygen to form $Al_2O_3$ | .100 | ..... | ..... | ..... | ..... | .02 | ..... |
| Total | 466.303 | 738.94 | 1,068.84 | 1,059.34 | 1,626.67 | 100.00 | ..... |
| Free ammonia | .163 | ..... | ..... | ..... | ..... | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... | ..... | ..... | ..... | ..... |
| Nitrogen as nitrates | .3 | ..... | ..... | ..... | ..... | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... | ..... | ..... | ..... | ..... |
| Oxygen required | .5 | ..... | ..... | ..... | ..... | ..... | ..... |

[a] Analyses of four springs.

### HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.514 | 0.11 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 2.9 | .62 |
| NaCl (sodium chlorid) | 1.2 | .26 |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 18.2 | 3.90 |
| $MgSO_4$ (magnesium sulphate) | 33.7 | 7.23 |
| $CaSO_4$ (calcium sulphate) | 13.9 | 2.98 |
| $MnSO_4$ (manganous sulphate) | .8 | .17 |
| $Al_2(SO_4)_3$ (aluminium sulphate) | 336.9 | 72.24 |
| $FeSO_4$ (ferrous sulphate) | 9.2 | 1.97 |
| $NaNO_3$ (sodium nitrate) | 1.83 | .39 |
| $Fe_2O_3$ (ferric oxid) | .4 | .09 |
| $SiO_2$ (silica) | 46.8 | 10.04 |
| Total | 466.344 | 100.00 |

No. 1224.—*Thompson's bromin and arsenic water, Crumpler, N. C.*

[Sodic bicarbonated alkaline (silicious and arsenic).]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 34.9; carbon dioxid (set free from bicarbonates on evaporating to dryness), 14.8.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 62.6 | 32.54 | 3,000 |
| $SO_4$ (sulphuric acid radicle) | 6.1 | 3.17 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 80.7 | 41.95 | 100 |
| $NO_3$ (nitric acid radicle) | 3.54 | 1.84 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | (*a*) | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | 666⅔ |
| $AsO_4$ (arsenic acid radicle) | Trace. | ..... | 666⅔ |
| Cl (chlorin) | 4.0 | 2.08 | 100 |
| Br (bromin) | (*b*) | ..... | 500 |
| I (iodin) | None. | ..... | 500 |
| Fe, Al (iron and aluminum) | 1.0 | .52 | 500 |
| Mm (manganese) | None. | ..... | 250 |
| Ca (calcium) | 7.0 | 3.64 | 500 |
| Mg (magnesium) | 2.2 | 1.14 | 500 |
| K (potassium) | 2.7 | 1.40 | 500 |
| Na (sodium) | 22.5 | 11.70 | 500 |
| Li (lithium) | (*c*) | ..... | 500 |
| $NH_4$ (ammonium) | .04 | .02 | 500 |
| Total | 192.38 | 100.00 | ..... |
| Free ammonia | .038 | ..... | ..... |
| Albuminoid ammonia | .112 | ..... | ..... |
| Nitrogen as nitrates | .80 | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... |
| Oxygen required | .75 | ..... | ..... |

*a* Heavy trace. *b* Faint trace. *c* Minute trace.

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.12 | 0.06 |
| LiCl (lithium chlorid) | (*a*) | ..... |
| KCl (potassium chlorid) | 5.20 | 2.70 |
| NaCl (sodium chlorid) | 2.30 | 1.20 |
| KBr (potassium bromid) | (*b*) | ..... |
| $Na_2SO_4$ (sodium sulphate) | 9.00 | 4.68 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | (*c*) | ..... |
| $NaNO_3$ (sodium nitrate) | 4.85 | 2.52 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 63.50 | 33.01 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 13.20 | 6.86 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 28.40 | 14.76 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 3.20 | 1.66 |
| $SiO_2$ (silica) | 62.60 | 32.55 |
| Total | 192.37 | 100.00 |

*a* Minute trace. *b* Faint trace. *c* Heavy trace.

No. 1225.—*Webster Springs salt sulphur water, Webster Springs, W. Va.*

[Sodic muriated saline (bromic), sulphureted.]

*Gases* (Number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (set free from bicarbonates on evaporating to dryness), 36.6; hydrogen sulphid, present.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 25.3 | 8.1 | 0.38 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 24.3 | 19.7 | .37 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 199.7 | ..... | 3.03 | 100 |
| $CO_3$ (carbonic acid radicle) | ..... | 135.6 | ..... | ..... |
| $NO_3$ (nitric acid radicle) | (*a*) | ..... | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | (*a*) | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | (*b*) | ..... | ..... | $333\frac{1}{3}$ |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | $333\frac{1}{3}$ |
| Cl (chlorin) | 3,816.6 | 3,973.3 | 57.84 | 100 |
| Br (bromin) | 26.9 | ..... | .41 | 500 |
| I (iodin) | .3 | ..... | ..... | 500 |
| Fe, Al (iron and aluminum) | 1.1 | ..... | .02 | 500 |
| Mn (manganese) | None. | ..... | ..... | 250 |
| Ca (calcium) | 188.5 | 212.1 | 2.86 | 500 |
| Mg (magnesium) | 43.0 | 49.2 | .65 | 500 |
| K (potassium) | 6.5 | ..... | .10 | 500 |
| Na (sodium) | 2,266.1 | 2,358.8 | 34.33 | 500 |
| Li (lithium) | .2 | ..... | ..... | 500 |
| $NH_4$ (ammonium) | .952 | ..... | .01 | 200 |
| Total | 6,599.452 | 6,756.8 | 100.00 | ..... |

*a* Faint trace. *b* Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Name. | Parts per million. | Per cent of total material. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 2.856 | 0.04 |
| LiCl (lithium chlorid) | 1.2 | .02 |
| NaCl (sodium chlorid) | 5,748.7 | 87.12 |
| $MgCl_2$ (magnesium chlorid) | 168.5 | 2.55 |
| $CaCl_2$ (calcium chlorid) | 315.3 | 4.78 |
| KBr (potassium bromid) | 19.5 | .30 |
| NaBr (sodium bromid) | 17.8 | .27 |
| KI (potassium iodid) | .4 | ..... |
| $CaSO_4$ (calcium sulphate) | 34.4 | .52 |
| $NaBO_2$ (sodium metaborate) | (*a*) | ..... |
| $NaNO_3$ (sodium nitrate) | (*b*) | ..... |
| $NaNO_2$ (sodium nitrite) | (*b*) | ..... |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 262.0 | 3.97 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 3.5 | .05 |
| $SiO_2$ (silica) | 25.3 | .38 |
| Total | 6,599.456 | 100.00 |

*a* Small amount. *b* Faint trace.

## DISCUSSION OF ANALYSES AND CORRESPONDENCE WITH SPRING OWNERS.

In the following pages a statement is made in regard to each spring, as to whether the analysis as found by the Bureau of Chemistry agrees with the advertised analysis, and if such is not the case a probable or possible explanation of the discrepancy is offered. A circular letter was sent to each spring owner informing him whether his advertised

analysis corresponded with the Bureau of Chemistry analysis, and if such was not the case, asking for any explanation that he might desire to make. A copy of the circular letter is given below, and in connection with the discussions of the analyses such extracts from the spring owners' replies are quoted as have a bearing on the case.

CIRCULAR LETTER TO SPRING OWNERS.

DEAR SIR: The Insecticide and Water Laboratory of this Bureau has, during the last year, been making a study of American mineral waters as they appear on the market. You will find inclosed a copy of the analysis which we have made of your spring water. This sample of water was obtained of ——— ——— and does (not) differ materially from the analysis given in your advertising matter.

We are sending every spring owner a copy of the analysis of his water before publishing the results, so that he may, if he so desire, explain any difference existing between the analysis as obtained by us and as given in the advertising matter. If the analyses do differ materially, any legitimate explanation which the spring owner may make will be carefully considered and published with the analysis of the spring.

Hoping that you will give this matter your early consideration, I remain,

Respectfully, H. W. WILEY, *Chief.*

POLAND WATER (No. 688 I. & W.).

While the Bureau of Chemistry analysis and the advertised analysis are not the same, they agree as closely as could be expected on two samples taken at different times. The spring owner was therefore advised that his analysis did not differ materially from the one obtained in the Bureau of Chemistry.

MASSANETTA WATER (No. 689 I. & W.).

The same may be said in regard to this water as has been said for the Poland water, with one exception, i. e., the determination of iron oxid and alumina. While the Bureau of Chemistry only found 0.5 part per million, the advertised analysis claims over 6 parts per million. This difference could easily be explained on the assumption that the iron and aluminum had largely precipitated out before the water was bottled. Although the owner was informed that his analysis agreed closely with that of the Bureau, the following communication was received from him:

I have no doubt of the correctness of your analysis, but have great doubts whether the water you analyzed was the pure Massanetta. Parties in Washington have, I have been informed, been selling other waters under the trade-mark for Massanetta. * * * This much I know. Some years ago we used to ship from 1,100 to 1,200 barrels to Washington and Philadelphia, and now I don't think we ship a dozen barrels to either city, and yet about as much Massanetta water is being sold as ever, according to my information. I have a letter from the brother of one man who sold Massanetta water in Washington, telling me that his employer ordered him to sell as little Massanetta as possible, but to sell all of the water he could from a spring his employer owned as Massanetta water.

VERONICA (No. 690 I. & W.).

This water is very heavily mineralized, containing over 22 grams of soluble salts per liter. The analysis of this Bureau differs markedly from the analysis as claimed by the spring owner. Just what the cause of this difference is it is impossible to state, although it is possible, in fact probable, that the composition of so heavily mineralized a water varies greatly from time to time, depending on the season, rainfall, level of ground water, etc. The owner's answer to the Bureau's letter is as follows:

Any difference you may have noted in mineral content of water from that published is only explainable as due to natural fluctuations in the salt content of a water so heavily mineralized.

BEDFORD MINERAL WATER (No. 691 I. & W.).

The Bureau of Chemistry analysis of this water agrees very closely with the advertised analysis, with one important exception, i. e., lithium. The Bureau analysis shows only an unweighable spectroscopic trace of lithium; the advertisement claims 0.61 part per million. While such a difference as the above is immaterial for most elements, it is important in the case of lithium, because waters are so highly prized on account of the presence of weighable amounts of this element. Even if the water contained the amount of lithium claimed by the owner, however, it would take about 50 liters to furnish a full medicinal dose.

TATE EPSOM WATER (No. 692 I. & W.).

The advertised and Bureau of Chemistry analyses of this water differ from each other materially. In the case of certain constituents the difference is very marked.

MISSISQUOI WATER (No. 869 I. & W.).

The advertised and Bureau of Chemistry analyses of this water do not differ more than would probably be expected in the case of samples taken on widely different dates.

WALLAWHATOOLA WATER (No. 870 I. & W.).

The advertised and Bureau of Chemistry analyses of this water differ from each other very materially, the owner claiming about seven times more salts than were found. It is of course possible that in the case of iron and aluminum these elements had partially precipitated out before the water was bottled. One point is clear, namely, that the water as bought by the Bureau on the open market and sold to consumers as Wallawhatoola does not have at all the composition claimed on the label. The letter from the spring owner follows:

I have compared the analysis you send with that of Wallawhatoola alum water, and am satisfied that by some error or mistake you have gotten an entirely different water. * * * If he [the agent] from whom the water was purchased bought the water through some other agent, there is one possible explanation that occurs to me. Sometimes during the summer empty Wallawhatoola water bottles have been used to send for water from a sulphur spring in the neighborhood, and I have reason to believe that some of these bottles of sulphur water have been mixed with the Wallawhatoola water; it is possible that thus you have gotten some of this sulphur water.

JEFFRESS LITHIA WATER (No. 871 I. & W.).

The composition of this water as found by the Bureau of Chemistry does not differ materially from the advertised analysis. It is, however, a misnomer to call this a lithia water.

GENEVA LITHIA WATER (No. 872 I. & W.).

The advertised analysis of this water differs very materially from the Bureau of Chemistry results, especially in the potassium and lithium figures. Although the water is advertised as containing a very large amount of lithium, 23.8 parts per million, it in reality contains only 0.1 part. It can therefore hardly be considered as a lithia water, as it would take about 300 liters of this water to give one full medicinal dose of lithium. A sample of this water obtained directly from the spring also showed the same very minute amount of lithium.

The company's answer to the circular letter of the Bureau of Chemistry was a visit from one of their representatives, who assured us that the analysis advertised by this company was offered in perfectly good faith and that they would at once have another analysis made, as they could hardly believe that the Bureau of Chemistry results were correct. As no further report has been made by the company, the above statement is published.

OTTERBURN LITHIA WATER (No. 873 I. & W.).

The composition of this water as determined by the Bureau of Chemistry does not differ materially from the advertised analysis. However, it is a misnomer to call it a lithia water, as it would take approximately 1,000 liters to give a full medicinal dose of lithium.

POWHATAN WATER (No. 874 I. & W.).

The retailer of this water was unable to furnish an advertised analysis.

BUFFALO LITHIA WATER (No. 900 I. & W.).

The advertised analysis of this water differs materially from the Bureau of Chemistry examination in nearly every determination, but especially in the potassium and lithium figures. In view of the explanation given below it is evidently possible that this may have been a

fictitious sample of the water. Two facts stand out beyond a doubt: (1) In this particular case consumers are paying for a water that is not true to label, and (2) it is a misnomer to term such a water a lithia water. Following is the letter received from the spring owner:

A sample of this water was submitted to Professor ———, of Baltimore, and the analysis as he furnished it to me was published in my pamphlet. In this connection I beg to state that spurious water is sold as "Buffalo lithia" in many of the large cities in this country. As evidences of this fact I beg to call your attention to the records of the New York supreme court: Myself against Reid, Yeomans & Cubit, druggists at 140 Nassau street, New York City; also to the records of the court of general sessions of the peace for the city and county of New York; myself against Charles F. Hanson, president of the Hanson Drug Company and proprietor of the drug store at 244 Sixth avenue, New York City; also to numerous other cases in different parts of the country. You will note that in each of these instances the parties were convicted of filling my bottles with spurious water and selling same as the genuine Buffalo lithia water. Some years since our representative bought some hundreds of thousands of the paper seals which we put over the cork of each bottle of Buffalo lithia water from a party in your city. Presumably this party was selling these counterfeit seals to bottlers there for the purpose of refilling Buffalo lithia-water bottles with spurious water.

HATHORN WATER, SARATOGA (No. 901 I. & W.).

The authors were unable to obtain the advertised analysis of this water. In Crook's work on Mineral Waters of the United States, however, is an analysis which is given in the table. It will be seen from this that although the analyses vary considerably from each other, yet in such heavily mineralized samples this variation is hardly more than would be expected from two samples taken on widely different dates. That these springs at Saratoga give every evidence of varying naturally to a very large extent in their mineral content, from time to time, will be brought out later in this bulletin.

CONGRESS WATER, SARATOGA, N. Y. (No. 902 I. & W.).

The same comment may be made in regard to this spring as on the Hathorn water, although here the variation between the advertised and the Bureau of Chemistry analyses is greater than in the previous case. The following letter was received from the spring owner:

We are unable to account for this difference in the analyses, unless the sample analyzed by you was bottled at a time when fresh water had found its way into the spring, which will occur occasionally.

VICHY WATER, SARATOGA, N. Y. (No. 903 I. & W.).

The variation in this case between the advertised and Bureau of Chemistry analyses is very great, the former analysis claiming over 6.3 grams of total salts per liter and the latter analysis finding only about 2.6 grams. It would appear that this spring has grown weaker

in its mineral content since the earlier analysis was made. The following letter was received from the owner:

There is no doubt in our opinion that mineral springs change in the different seasons of the year in regard to the water and flow. We have also noticed changes in the mineral waters or mineral springs in this section of the country before a storm or heavy atmosphere.

MARDELA WATER (No. 904 I. & W.).

There is considerable variation in the two analyses of this water, especially in the iron figure, the advertised analysis showing 138.1 parts per million and the Bureau of Chemistry only finding 13.6 parts. It is of course possible that the spring, as it issues from the ground, contains the quantity of iron claimed, but if such is the case it had precipitated out before bottling the sample purchased by the Bureau of Chemistry.

VITAN TABLE WATER (No. 905 I. & W.).

While there is considerable variation between the two analyses of this water the mineral content is so small that the variation may be considered as of no significance.

BLUE LICK WATER (No. 1009 I. & W.).

This sample is so highly mineralized that such difference as exists between the advertised and Bureau of Chemistry analyses would probably be expected on account of the samples having been taken at different times. Following is the owner's letter:

In reference to the Blue Lick, which you recently analyzed, we have been in correspondence with Messrs. ——— & Co., from whom you purchased the water, and they state that they have been in the mineral-water business now almost three years, and that they found the water in the stock of waters they bought of their predecessor, and according to our books this water was shipped from here in a wooden barrel about three years since, and our water does not keep very well in wood for over six months. The consequences are that the water you had to examine was of very poor quality and certainly not up to the standard.

SUBLETT LITHIA WATER (No. 1010 I. & W.).

While there is considerable variation between the advertised and Bureau of Chemistry analyses, the difference could easily be accounted for by changes in the composition of the water from time to time. This appears as the most likely explanation in view of the owner's statement in the following letter. It is a misnomer to call this a lithia water.

Professor ——— came to the spring from Richmond and analyzed it. The capacity of this spring is 1 gallon per minute in ordinary weather, but if we have exceedingly wet weather it causes the spring to increase its flow. We never bottle any of the

water when the flow of the spring is very much increased, but do remember on several occasions having to bottle when the flow was 1¼ to 1½ gallons per minute to supply the demand. We expect the sample you obtained was water taken at that time.

Osceola Water (No. 1011 I. & W.).

While there is some variation between the advertised and Bureau of Chemistry analyses, the difference could easily be accounted for by natural changes in the water from time to time.

Golindo Lithia Water (No. 1012 I. & W.).

The same may be said for this spring as was said for the Osceola. To this may be added that the spring hardly contains enough lithium to be called a lithia water.

Cherrydale Water (No. 1013 I. & W.).

The authors were unable to obtain the advertised analysis of this spring.

Deep Rock Water (No. 1020 I. & W.).

The authors were unable to obtain the advertised analysis of this water, but a comparison of their analysis with the analysis in Crook's shows an astounding variation, which can hardly be explained on the basis of natural changes in the composition of the water of the spring. This variation is particularly noticeable in the determination of silica and potassium. A sample of the water obtained directly from the spring showed the same small amounts of the last two mentioned elements.

Champion Water, Saratoga, N. Y. (No. 1021 I. & W.).

The variation between the Bureau of Chemistry analysis and the advertised analysis is in this case so large as to make it appear that the Champion water has grown much weaker in its mineral content since the time the latter examination was made.

Allouez Magnesia Water (No. 1022 I. & W.).

The authors were unable to obtain the published analysis of this spring, but the analysis in Crook's differs materially from the Bureau of Chemistry examination.

Mount Clemens Water (No. 1023 I. & W.).

In this case again the authors were unable to obtain the published analysis. The analysis in Crook's differs very materially from the Bureau of Chemistry analysis. In a water so highly mineralized as this one, however a large amount of variation is to be expected from time to time.

BERRY HILL DYSPEPSIA WATER (No. 1024 I. & W.).

The advertised and the Bureau of Chemistry analyses of this water agree with each other quite closely in most cases. The owners, however, claim 8.9 parts per million of hypophosphorous acid ions, while the authors were not able to find, and in fact hardly expected to find, any of this acid.

GITCHE CRYSTAL SPRING WATER (No. 1025 I. & W.).

The authors were unable to obtain the advertised mineral analysis of this spring. The sanitary analysis, although differing from that advertised, as would be expected, was satisfactory.

GREAT BEAR WATER (No. 1026 I. & W.).

The advertised and Bureau of Chemistry analyses agree very satisfactorily with one another except for chlorin, and even this difference is of no importance and is explained satisfactorily by the owner's letter, which follows:

Regarding the amount of chlorin which your analysis of our water shows, we are advised by competent authority that even if correct it would not under our conditions indicate contamination, as our springs are remote from any habitation. They are, however, but 20 miles from the salt deposits of Syracuse, and wells bored to any considerable depth in the vicinity of our springs produce salt water.

It is only fair to the owners of this spring to say that although the first sample of Great Bear purchased by us undoubtedly contained 21.5 parts of chlorin per million, subsequent samples were examined which contained approximately the amount of chlorin given in the advertised analysis. It is also probable that the first sample was entirely genuine and that the variation in the amount of chlorin was caused by the salt deposits as suggested.

LONDONDERRY LITHIA WATER (No. 1116 I. & W.).

The difference between the advertised and the Bureau of Chemistry analyses of this water is remarkable. Not only are the analyses different to a marked extent in nearly every item, but particularly is this noticeable in the case of lithium, the advertised analysis giving 10.3 parts per million while the Bureau of Chemistry examination shows only a spectroscopic trace. It is needless to say that it is a misnomer to call the water purchased by us under the name of "Londonderry lithia water" a lithia water.

WHITE ROCK LITHIA WATER (No. 1117 I. & W.).

While there is some variation between the advertised and Bureau of Chemistry analyses of this water it is not significant except in the case of lithium. For this element the advertised analysis claims 38.1 parts

per million, while the Bureau of Chemistry results show 12.6 parts. However, with the amount present as found by the Bureau of Chemistry, the water may be considered fairly rich in this element, as it amounts to 1.05 per cent of the total salts present.

CROCKETT ARSENIC LITHIA WATER (No. 1119 I. & W.).

On the whole, the advertised analysis of this water agrees very well with that found by the Bureau of Chemistry, differing no more than would perhaps be expected of samples taken at different times. However, it is a misnomer to term such a water as this a lithia water.

PLUTO CONCENTRATED WATER (No. 1126 I. & W.).

The advertised and Bureau of Chemistry analyses of this water differ quite materially from one another. This is, however, to be expected in the case of so concentrated a sample. The following statement was received from the owner: "We are having the water reanalyzed to ascertain what change, if any, has taken place."

RED RAVEN APERIENT WATER (No. 1121 I. & W.).

The Bureau of Chemistry was unable to obtain the advertised analysis of this water.

AUGUSTA WHITE LITHIA WATER (No. 1122 I. & W.).

While there is some little variation between the advertised and Bureau of Chemistry analyses, it is no more than would be expected from two samples taken at different times. However, it is a misnomer to call such a water as this a lithia water.

BEAR LITHIA WATER (No. 1123 I. & W.).

The same may be said of this water as was said in the paragraph preceding in regard to Augusta White Lithia Water.

SHEBOYGAN WATER (No. 1220 I. & W.).

The authors were unable to obtain the advertised mineral analysis of this water. The sanitary analysis made at the Bureau of Chemistry, while not necessarily meaning that the water is contaminated in any way, does not show the water in quite so favorable a light as does the advertised analysis. The following letter was received from the owner in regard to this matter:

Referring to your analysis of Sheboygan mineral water, we herewith beg to submit reports on bacteriological and chemical analysis of the same water, one made by Professor ——— on October 25, 1902, and two reports by Doctor ———, made a short time ago. The report of Doctor ———, marked No. 3, was of water taken from our stock bottled six weeks ago. Doctor ———'s report, No. 4, was bottled on the 20th instant.

These three reports show Sheboygan mineral water to be a very pure water and much better than your report would indicate. This difference is very readily traced to some trouble we were having last year with the pipe line which supplies our plant with the mineral water. This pipe line is about one-fourth of a mile in length and leaked a few times last year, and was undoubtedly leaking at the time the water was bottled which you examined. This pipe line has been in for fifteen years, but as soon as the ground is in condition we will lay new pipe, so as to avoid any possible pollution hereafter. However, we have detected no leakage in the pipe since it was repaired December 1.

The mineral water flows from an artesian well 1,475 feet deep, with natural pressure of 52.5 pounds to the square inch. This well is piped with a copper pipe which extends 400 feet into the rock, and is securely fastened to the rock at the foot with a heavy expansive packing. This seals the pipe securely, and no surface water can possibly enter the well. In justice to Sheboygan mineral water, we would request you to make another examination of the same.

*Inclosed analyses.*

| Constituents. | Parts per million. | | |
|---|---|---|---|
| | Oct. 25, 1902. | No. 3. | No. 4. |
| Free ammonia | 0.00 | 0.05 | 0.01 |
| Albuminoid ammonia | .01 | Trace. | .10 |
| Nitrites | .00 | None. | None. |
| Nitrates | .00 | None. | None. |
| Chlorin | 1,350.00 | 1,312.50 | 1,260.00 |
| Oxygen-consuming capacity | .00 | 1.6 | 1.68 |
| Pathogenic bacteria | None. | None. | None. |

In view of the explanation given in the above letter, another sample of the water was purchased on the open market and subjected to a sanitary examination, with the following results:

| | Parts per million. |
|---|---|
| Free ammonia | 0.10 |
| Albuminoid ammonia | .02 |
| Nitrites | Considerable. |
| Nitrates | None. |

This analysis shows a considerable reduction in the albuminoid ammonia figure, which was the only one that was at all unsatisfactory in the analysis as originally made. The considerable quantity of nitrites has no significance in an artesian well water, such as is described above.

### Manitou Table Water (No. 1221 I. & W.).

The advertised and Bureau of Chemistry analyses of this water agree very satisfactorily with each other with one exception, i. e., lithium, the Bureau only finding 0.23 part per million, while the advertised analysis claims 2.3 parts per million.

### Rubino Healing Springs Water (No. 1222 I. & W.).

The same may be said of this water as was said for the Manitou, except that the Bureau analysis shows only a spectroscopic trace of lithium, while the advertised analysis gives 0.91 part per million.

ROCKBRIDGE ALUM WATER (No. 1223 I. & W.).

The composition of this water as determined by the Bureau shows that it is markedly weaker in mineral content than even the least highly mineralized of the springs as shown in the advertised analyses. This is very likely due either to a gradual change in the composition of the spring since the advertised analyses were made or to fluctuations in the composition from time to time. The following letter was received from the spring owner:

It may or it may not be a fair sample you obtained. Our mineral water comes from rain percolating through a mass of mineral rock, the constituent parts coming to the surface during dry weather, the rain bringing it into the springs, so that during a dry time the water is materially weaker than during a wet spell or just after the rain.

Except for special orders, we mix the various springs before bottling, and the water you analyzed may have been from the weaker spring. The published analysis made by Professor ——— was made after the following preparation. He remained at the springs two months, taking water from each spring two or three times a week during the entire time, and on this he made his analysis.

THOMPSON'S BROMIN ARSENIC WATER (No. 1224 I. & W.).

The authors were unable to obtain the published analysis of this water. It is something of a misnomer to designate this a "bromin" water.

WEBSTER SPRINGS SALT SULPHUR WATER (No. 1225 I. & W.).

The agreement between the advertised and Bureau of Chemistry analyses of this spring is as satisfactory as could be expected on two samples taken at different times.

## III. SARATOGA WATERS SAMPLED AT SOURCE.

Besides examining the miscellaneous waters described in Part II of this report, all of which were purchased upon the open market, the authors also made a study of the springs at Saratoga, N. Y., as they come from the ground. An agent of the Department visited Saratoga and collected the samples. In practically all cases the springs were walled up so that it was impossible to take samples directly from the source. Such being the case samples were taken at the nearest outlet of the spring.

The samples were shipped to the laboratory at Washington, D. C., in the bottles ordinarily used at the various springs, and when received all samples from the same spring were mixed in a clean, large, glass demijohn, and subjected to immediate analysis. The authors would have preferred to ship these samples in 5-gallon glass demijohns, which are more resistant to the action of the water than the bottles obtained from the spring owners, but feared to do so on account of the danger of the large amount of carbon dioxid in the waters bursting the bottles. Since the samples were not in these bottles for any great length of time, however, it seems hardly possible that any material amount of the glass was dissolved.

The headings in the following tables have the same significance as in the reports previously presented. It should, of course, be borne in mind that the figure for free carbon dioxid represents the sample as it was received at the laboratory and is lower than the true amount of free carbon dioxid in the water fresh from the spring.

## CHEMICAL COMPOSITION.

No. 1358.—*Vichy water, Saratoga, N. Y.*

[Sodic muriated alkaline-saline, carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 255; carbon dioxid (set free from bicarbonates on evaporating to dryness), 125.6.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 14.7 | 0.60 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 16.7 | .68 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 684.3 | 28.04 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 893.3 | 36.60 | 100 |
| Br (bromin) | Trace. | ..... | 500 |
| I (iodin) | Trace. | ..... | 500 |
| Fe, Al (iron and aluminum) | 4.2 | .17 | 500 |
| Ca (calcium) | 41.3 | 1.69 | 500 |
| Mg (magnesium) | 9.1 | .37 | 500 |
| Ba (barium) | .06 | ..... | 2,000 |
| Sr (strontium) | None. | ..... | 2,000 |
| K (potassium) | 3.8 | .16 | 500 |
| Na (sodium) | 772.1 | 31.63 | 500 |
| Li (lithium) | .65 | .03 | 500 |
| $NH_4$ (ammonium) | .714 | .03 | 200 |
| Total | 2,440.924 | 100.00 | ..... |
| Free ammonia | .675 | ..... | ..... |
| Albuminoid ammonia | Trace. | ..... | ..... |
| Nitrogen as nitrates | Trace. | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 2.11 | 0.09 |
| LiCl (lithium chlorid) | 3.94 | .16 |
| KCl (potassium chlorid) | 7.2 | .30 |
| NaCl (sodium chlorid) | 1,459.5 | 59.79 |
| $Na_2SO_4$ (sodium sulphate) | 24.7 | 1.01 |
| $NaBO_2$ (sodium metaborate) | Trace. | ..... |
| $NaNO_3$ (sodium nitrate) | Trace. | ..... |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 693.1 | 28.40 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | .11 | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 54.8 | 2.25 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 167.3 | 6.85 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 13.4 | .55 |
| $SiO_2$ (silica) | 14.7 | .60 |
| Total | 2,440.86 | 100.00 |

No. 1359.—*Hathorn water, Saratoga, N. Y.*

[Sodic muriated alkaline-saline (ferruginous, bromic, and iodic).]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 75.0; carbon dioxid (set free from bicarbonates on evaporating to dryness), 658.2.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 19.6 | 0.18 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 5.6 | .05 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 3,585.6 | 33.02 | 100 |
| $NO_3$ (nitric acid radicle) | None. | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | (a) | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 3,685.5 | 33.95 | 100 |
| Br (bromin) | 26.9 | .25 | 200 |
| I (iodin) | 1.5 | .01 | 500 |
| Fe, Al (iron and aluminum) | 9.8 | .09 | 500 |
| Ca (calcium) | 650.7 | 6.00 | 100 |
| Mg (magnesium) | 228.8 | 2.11 | 100 |
| Ba (barium) | 5.5 | .05 | 2,000 |
| Sr (strontium) | Trace. | ..... | 2,000 |
| K (potassium) | 197.2 | 1.82 | 500 |
| Na (sodium) | 2,430.7 | 22.38 | 500 |
| Li (lithium) | .5 | ..... | 500 |
| $NH_4$ (ammonium) | 10.7 | .09 | 200 |
| Total | 10,858.6 | 100.00 | ..... |
| Free ammonia | 10.1 | ..... | ..... |
| Albuminoid ammonia | Trace. | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... |

(a) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 31.8 | 0.29 |
| LiCl (lithium chlorid) | 3.0 | .03 |
| KCl (potassium chlorid) | 350.7 | 3.23 |
| NaCl (sodium chlorid) | 5,762.4 | 53.06 |
| KBr (potassium bromid) | 40.0 | .37 |
| KI (potassium iodid) | 1.9 | .02 |
| $Na_2SO_4$ (sodium sulphate) | 8.2 | .08 |
| $NaBO_2$ (sodium metaborate) | (a) | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 586.4 | 5.40 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 10.4 | .09 |
| $Sr(HCO_3)_2$ (strontium bicarbonate) | Trace. | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 1,377.8 | 12.69 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 2,635.3 | 24.27 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 31.1 | .29 |
| $SiO_2$ (silica) | 19.6 | .18 |
| Total | 10,858.6 | 100.00 |

(a) Small amount.

No. 1360.—*Arondack water, Saratoga, N. Y.*

[Sodic muriated saline (lithic, bromic) carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 396.5; carbon dioxid (set free from bicarbonates on evaporating to dryness), 51.3.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 9.2 | 5.0 | 0.30 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 503.9 | 466.3 | 16.29 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 275.5 | 373.4 | 8.90 | 100 |
| $NO_3$ (nitric acid radicle) | 11.9 | 36.3 | .38 | 100 |
| $NO_2$ (nitrous acid radicle) | .016 | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 1,185.9 | 1,132.7 | 38.33 | 100 |
| Br (bromin) | 11.8 | ..... | .38 | 500 |
| I (iodin) | None. | ..... | ..... | 500 |
| Fe, Al (iron and aluminum) | 3.5 | 1.0 | .11 | 500 |
| Ca (calcium) | 25.7 | 35.8 | .83 | 500 |
| Mg (magnesium) | 90.6 | 103.8 | 2.93 | 500 |
| Ba (barium) | .06 | ..... | ..... | 2,000 |
| Sr (strontium) | None. | ..... | ..... | 2,000 |
| K (potassium) | 144.7 | 170.4 | 4.68 | 500 |
| Na (sodium) | 827.3 | 746.5 | 26.74 | 500 |
| Li (lithium) | 2.5 | 9.3 | .08 | 500 |
| $NH_4$ (ammonium) | .185 | ..... | ..... | 500 |
| Oxygen to form $Fe_2O_3$ | 1.5 | ..... | .05 | ..... |
| Total | 3,094.261 | 3,080.5 | 100.00 | ..... |
| Free ammonia | .175 | ..... | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... | ..... |
| Nitrogen as nitrates | 2.7 | ..... | ..... | ..... |
| Nitrogen as nitrites | .005 | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.56 | 0.02 |
| LiCl (lithium chlorid) | 15.2 | .49 |
| KCl (potassium chlorid) | 265.3 | 8.57 |
| NaCl (sodium chlorid) | 1,725.1 | 55.76 |
| KBr (potassium bromid) | 17.5 | .57 |
| $Na_2SO_4$ (sodium sulphate) | 444.9 | 14.38 |
| $MgSO_4$ (magnesium sulphate) | 254.5 | 8.23 |
| $NaNO_3$ (sodium nitrate) | 16.3 | .53* |
| $NaNO_2$ (sodium nitrite) | .0246 | ..... |
| $Ba(HCO_3)_2$ (barium bicarbonate) | .11 | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 236.2 | 7.63 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 104.1 | 3.36 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 5.0 | .16 |
| $SiO_2$ (silica) | 9.2 | .30 |
| Total | 3,093.9946 | 100.00 |

## No. 1361.—*Geyser water, Saratoga, N. Y.*

[Sodic bicarbonated alkaline (ferruginous, lithic, bromic, iodic) carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure.—Carbon dioxid (free), 181.8; carbon dioxid (set free from bicarbonates on evaporating to dryness), 799.1.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 20.8 | 0.27 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 1.4 | .02 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 4,353.2 | 56.85 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | (*a*) | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 1,025.1 | 13.40 | 100 |
| Br (bromin) | 11.8 | .15 | 500 |
| I (iodin) | 1.0 | .01 | 500 |
| Fe, Al (iron and aluminum) | 8.4 | .11 | 500 |
| Ca (calcium) | 116.4 | 1.52 | 500 |
| Mg (magnesium) | 60.6 | .79 | 500 |
| Ba (barium) | 2.6 | .03 | 2,000 |
| Sr (strontium) | Trace. | ..... | 2,000 |
| K (potassium) | 29.0 | .38 | 500 |
| Na (sodium) | 2,010.9 | 26.27 | 500 |
| Li (lithium) | 3.6 | .05 | 500 |
| $NH_4$ (ammonium) | 11.4 | .15 | 100 |
| Total | 7,656.2 | 100.00 | ..... |
| Free ammonia | 10.8 | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... |
| Nitrogen as nitrates | Trace. | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... |

(*a*) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 33.8 | 0.44 |
| LiCl (lithium chlorid) | 21.8 | .28 |
| KCl (potassium chlorid) | 43.9 | .57 |
| NaCl (sodium chlorid) | 1,588.8 | 20.75 |
| KBr (potassium bromid) | 17.5 | .23 |
| KI (potassium iodid) | 1.3 | .02 |
| $Na_2SO_4$ (sodium sulphate) | 2.1 | .03 |
| $NaBO_2$ (sodium metaborate) | (*a*) | ..... |
| $NaNO_3$ (sodium nitrate) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 5,058.3 | 66.07 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 4.9 | .06 |
| $Sr(HCO_3)_2$ (strontium bicarbonate) | Trace. | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 364.9 | 4.77 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 471.4 | 6.16 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 26.7 | .35 |
| $SiO_2$ (silica) | 20.8 | .27 |
| Total | 7,656.2 | 100.00 |

(*a*) Small amount.

## No. 1362.—*Peerless water, Saratoga, N. Y.*

[Sodic and calcic muriated alkaline-saline (ferruginous, bromic, iodic) carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure.—Carbon dioxid (free), 192.6; carbon dioxid (set free from bicarbonates on evaporating to dryness), 483.6.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 14.8 | 0.23 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 4.0 | 0.6 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 2,634.4 | 40.71 | 100 |
| $NO_3$ (nitric acid radicle | None. | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | Trace, | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 1,773.1 | 27.40 | 100 |
| Br (bromin) | 16.8 | .26 | 200 |
| I (iodin) | 1.0 | .02 | 500 |
| Fe\| (iron and aluminum) Al\| | 5.6 | .09 | 500 |
| Ca (calcium) | 530.4 | 8.19 | 500 |
| Mg (magnesium) | 90.9 | 1.40 | 500 |
| Ba (barium) | 2.1 | .03 | 2,000 |
| Sr (strontium) | None. | ..... | 2,000 |
| K (potassium) | 94.7 | 1.46 | 500 |
| Na (sodium) | 1,298.5 | 20.06 | 500 |
| Li (lithium) | .44 | ..... | 500 |
| $NH_4$ (ammonium) | 5.88 | .09 | 100 |
| Total | 6,472.62 | 100.00 | ..... |
| Free ammonia | 5.55 | ..... | ..... |
| Albuminoid ammonia | Trace. | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 17.46 | 0.27 |
| LiCl (lithium chlorid) | 2.64 | .04 |
| KCl (potassium chlorid) | 164.5 | 2.54 |
| NaCl (sodium chlorid) | 2,771.6 | 42.82 |
| KBr (potassium bromid) | 25.0 | .39 |
| KI (potassium iodid) | 1.3 | .02 |
| $Na_2SO_4$ (sodium sulphate) | 5.9 | .09 |
| $NaBO_2$ (sodium metaborate) | Trace. | ..... |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 752.3 | 11.62 |
| $BaHCO_3)_2$ (barium bicarbonate) | 3.9 | .06 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 547.3 | 8.45 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 2,148.1 | 33.19 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 17.8 | .28 |
| $SiO_2$ (silica) | 14.8 | .23 |
| Total | 6,472.6 | 100.00 |

## No. 1363.—*Magnetic water, Saratoga, N. Y.*

[Sodic and calcic muriated alkaline saline (ferruginous, lithic, bromic).]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 33.7; carbon dioxid (set free from bicarbonates on evaporating to dryness), 333.5.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 42.7 | 0.91 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 2.3 | .05 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 1,816.8 | 38.87 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 1,313.4 | 28.09 | 100 |
| Br (bromin) | 11.8 | .25 | 500 |
| I (iodin) | .3 | ..... | 500 |
| Fe, Al (iron and aluminum) | 97.8 | 2.09 | 500 |
| Ca (calcium) | 326.4 | 6.98 | 500 |
| Mg (magnesium) | 122.8 | 2.63 | 500 |
| Ba (barium) | 4.4 | .09 | 2,000 |
| Sr (strontium) | Trace. | ..... | 2,000 |
| K (potassium) | 56.9 | 1.22 | 500 |
| Na (sodium) | 849.7 | 18.17 | 500 |
| Li (lithium) | 3.2 | .07 | 500 |
| $NH_4$ (ammonium) | 3.42 | .07 | 200 |
| Oxygen to form $Fe_2O_3$ | 24.0 | .51 | ..... |
| Total | 4,675.92 | 100.00 | ..... |
| Free ammonia | 3.23 | ..... | ..... |
| Albuminoid ammonia | .55 | ..... | ..... |
| Nitrogen as nitrates | Trace. | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 10.16 | 0.22 |
| LiCl (lithium chlorid) | 19.40 | .41 |
| KCl (potassium chlorid) | 97.5 | 2.09 |
| NaCl (sodium chlorid) | 2,051.3 | 43.88 |
| KBr (potassium bromid) | 17.5 | .37 |
| KI (potassium iodid) | .4 | .01 |
| $Na_2SO_4$ (sodium sulphate) | 3.4 | .07 |
| $NaBO_2$ (sodium meta borate) | Trace. | ..... |
| $NaNO_3$ (sodium nitrate) | Trace. | ..... |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 151.2 | 3.23 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 8.3 | .18 |
| $Sr(HCO_3)_2$ (strontium bicarbonate) | Trace. | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 739.3 | 15.81 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 1,321.9 | 28.27 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 132.9 | 2.84 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 80.0 | 1.71 |
| $SiO_2$ (silica) | 42.7 | .91 |
| Total | 4,675.96 | 100.00 |

No. 1390.—*Star water, Saratoga, N. Y.*

[Sodic, muriated saline, carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 766.4; carbon dioxid (set free from bicarbonates on evaporating to dryness), 86.7.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 13.7 | 10.2 | 0.46 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 47.0 | 39.9 | 1.59 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 472.4 | 597.3 | 15.98 | 100 |
| $NO_3$ (nitric acid radicle) | 44.3 | 8.4 | 1.50 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | 2.34 | ..... | .08 | 500 |
| $BO_2$ (metaboric acid radicle) | None. | ..... | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 1,325.8 | 1,312.0 | 44.82 | 100 |
| Br (bromin) | .2 | ..... | ..... | 500 |
| I (iodin) | Trace. | ..... | ..... | 500 |
| Fe, Al (iron and aluminum) | 3.2 | 4.8 | .11 | 500 |
| Ca (calcium) | 120.5 | 150.1 | 4.07 | 500 |
| Mg (magnesium) | 25.4 | 26.9 | .86 | 500 |
| Ba (barium) | .4 | ..... | .01 | 2,000 |
| Sr (strontium) | None. | ..... | ..... | 2,000 |
| K (potassium) | 23.1 | 26.2 | .78 | 500 |
| Na (sodium) | 878.1 | 861.6 | 29.69 | 500 |
| Li (lithium) | Trace. | ..... | ..... | 500 |
| $NH_4$ (ammonium) | .29 | ..... | .01 | 500 |
| Oxygen to form $Fe_2O_3$ | 1.3 | ..... | .04 | ..... |
| Total | 2,958.03 | 3,037.4 | 100.00 | ..... |
| Free ammonia | .28 | ..... | ..... | ..... |
| Albuminoid ammonia | .10 | ..... | ..... | ..... |
| Nitrogen as nitrates | 10.00 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.87 | 0.03 |
| LiCl (lithium chlorid) | Trace. | ..... |
| KCl (potassium chlorid) | 43.9 | 1.48 |
| NaCl (sodium chlorid) | 2,150.5 | 72.71 |
| KBr (potassium bromid) | .3 | .01 |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 47.9 | 1.62 |
| $MgSO_4$ (magnesium sulphate) | 18.3 | .62 |
| $Ca_3(PO_4)_2$ (calcium phosphate) | 3.8 | .13 |
| $NaNO_3$ (sodium nitrate) | 60.7 | 2.05 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Ba(HCO_3)_2$ (barium bicarbonate) | .8 | .03 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 130.8 | 4.42 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 481.9 | 16.29 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 4.5 | .15 |
| $SiO_2$ (silica) | 13.7 | .46 |
| Total | 2,957.97 | 100.00 |

## No. 1391.—*Seltzer water, Saratoga, N. Y.*

[Sodic and calcic, muriated, alkaline-saline (ferruginous, bromic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 762.8; carbon dioxid (set free from bicarbonates on evaporating to dryness), 204.5.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 40.4 | 43.9 | 1.48 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 20.2 | 5.2 | .74 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 1,114.3 | 2,092.12 | 40.70 | 100 |
| $NO_3$ (nitric acid radicle) | 4.4 | ..... | .17 | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | None. | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 720.1 | 1,406.8 | 26.33 | 100 |
| Br (bromin) | 6.7 | 8.4 | .24 | 500 |
| I (iodin) | .3 | .42 | .01 | 500 |
| Fe (iron) | ..... | 9.2 | ..... | ..... |
| Fe, Al (iron and aluminum) | 5.1 | ..... | .19 | 500 |
| $Al_2O_3$ (alumina) | ..... | 6.4 | ..... | ..... |
| Ca (calcium) | 247.0 | 380.7 | 9.02 | 500 |
| Mg (magnesium) | 67.5 | 114.9 | 2.47 | 500 |
| Ba (barium) | .7 | Trace. | .03 | 2,000 |
| Sr (strontium) | None. | Trace. | ..... | 2,000 |
| K (potassium) | 48.4 | 16.3 | 1.77 | 500 |
| Na (sodium) | 456.9 | 1,094.28 | 16.68 | 500 |
| Li (lithium) | .06 | 1.58 | ..... | 500 |
| $NH_4$ (ammonium) | 2.59 | ..... | .09 | 200 |
| Oxygen to form $Fe_2O_3$ | 2.20 | ..... | .08 | ..... |
| Total | 2,736.85 | 5,180.2 | 100.00 | ..... |
| Free ammonia | 2.45 | ..... | ..... | ..... |
| Albuminoid ammonia | .10 | ..... | ..... | ..... |
| Nitrogen as nitrates | 1.00 | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 7.69 | 0.28 |
| LiCl (lithium chlorid) | .36 | .01 |
| KCl (potassium chlorid) | 85.9 | 3.14 |
| NaCl (sodium chlorid) | 1,111.0 | 40.60 |
| KBr (potassium bromid) | 10.0 | .37 |
| KI (potassium iodid) | .4 | .01 |
| $Na_2SO_4$ (sodium sulphate) | 29.9 | 1.09 |
| $NaNO_3$ (sodium nitrate) | 6.0 | .22 |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 30.6 | 1.12 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 1.3 | .05 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 405.6 | 14.82 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 1,000.4 | 36.54 |
| $Mn_3O_4$ (mangano-manganic oxid) | 7.3 | .27 |
| $SiO_2$ (silica) | 40.4 | 1.48 |
| Total | 2,736.85 | 100.00 |

No. 1392.—*High Rock water, Saratoga, N. Y.*

[Sodic and calcic muriated alkaline-saline (ferruginous, bromic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 171.7; carbon dioxid (set free from bicarbonates on evaporating to dryness), 204.5.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 33.4 | 1.42 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 15.7 | .67 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 1,114.0 | 47.47 | 100 |
| $NO_3$ (nitric acid radicle) | 6.6 | .28 | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 483.3 | 20.59 | 100 |
| Br (bromin) | 6.7 | .29 | 500 |
| I (iodin) | .15 | ..... | 500 |
| Fe, Al (iron and aluminum) | 12.3 | .52 | 500 |
| Ca (calcium) | 223.9 | 9.54 | 500 |
| Mg (magnesium) | 60.6 | 2.58 | 500 |
| Ba (barium) | .7 | .03 | 2,000 |
| Sr (strontium) | None. | ..... | 2,000 |
| K (potassium) | 34.3 | 1.46 | 500 |
| Na (sodium) | 348.0 | 14.83 | 500 |
| Li (lithium) | .89 | .04 | 500 |
| $NH_4$ (ammonium) | 1.5 | .06 | 200 |
| Oxygen to form $Fe_2O_3$ | 5.2 | .22 | ..... |
| Total | 2,347.24 | 100.00 | ..... |
| Free ammonia | 1.42 | ..... | ..... |
| Albuminoid ammonia | .03 | ..... | ..... |
| Nitrogen as nitrates | 1.50 | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 4.45 | 0.20 |
| LiCl (lithium chlorid) | 5.34 | .23 |
| KCl (potassium chlorid) | 59.2 | 2.52 |
| NaCl (sodium chlorid) | 738.2 | 31.44 |
| KBr (potassium bromid) | 10.0 | .43 |
| KI (potassium iodid) | .19 | .01 |
| $Na_2SO_4$ (sodium sulphate) | 23.2 | .99 |
| $NaBO_2$ (sodium metaborate) | Trace. | ..... |
| $NaNO_3$ (sodium nitrate) | 9.0 | .38 |
| $Na(HCO_3)$ (sodium bicarbonate) | 173.8 | 7.40 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 1.3 | .06 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 364.9 | 15.54 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 906.8 | 38.63 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 17.5 | .75 |
| $SiO_2$ (silica) | 33.4 | 1.42 |
| Total | 2,347.28 | 100.00 |

## No. 1393.—*Lincoln water, Saratoga, N. Y.*

[Sodic and calcic, muriated, alkaline-saline (ferruginous, lithic, bromic, iodic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 402.6; carbon dioxid (set free from bicarbonates on evaporating to dryness), 775.0.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 32.7 | 0.26 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 3.5 | .03 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 4,221.0 | 34.13 | 100 |
| $NO_3$ (nitric acid radicle) | Trace. | ..... | 100 |
| $NO_2$ nitrous acid radicle) | None. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 4,068.0 | 32.90 | 100 |
| Br (bromin) | 76.0 | .61 | 1,000 |
| I (iodin) | 1.9 | .02 | 500 |
| Fe, Al (iron and aluminum) | 13.9 | .11 | 500 |
| Ca (calcium) | 675.8 | 5.46 | 200 |
| Mg (magnesium) | 325.9 | 2.63 | 200 |
| Ba (barium) | 11.7 | .09 | 2,000 |
| Sr (strontium) | None. | ..... | 2,000 |
| K (potassium) | 243.7 | 1.96 | 500 |
| Na (sodium) | 2,688.0 | 21.73 | 500 |
| Li (lithium) | 1.8 | .01 | 500 |
| $NH_4$ (ammonium) | 7.3 | .06 | 200 |
| Total | 12,371.2 | 100.00 | ..... |
| Free ammonia | 6.93 | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... |
| Nitrogen as nitrates | Trace. | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 21.8 | 0.18 |
| LiCl (lithium chlorid) | 10.8 | .09 |
| KCl (potassium chlorid) | 393.4 | 3.18 |
| NaCl (sodium chlorid) | 6,359.8 | 51.40 |
| KBr (potassium bromid) | 113.0 | .91 |
| KI (potassium iodid) | 2.5 | .02 |
| $Na_2SO_4$ (sodium sulphate) | 5.2 | 0.4 |
| $NaBO_2$ (sodium metaborate) | (a) | ..... |
| $NaNO_3$ (sodium nitrate) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 666.6 | 5.39 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 22.1 | .19 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 1,962.1 | 15.86 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 2,737.0 | 22.12 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 44.2 | .36 |
| $SiO_2$ (silica) | 32.7 | .26 |
| Total | 12,371.2 | 100.00 |

a Small amount.

No. 1394.—*Chief water, Saratoga, N. Y.*

[Sodic and calcic, muriated, alkaline-saline (lithic, bromic, iodic), carbondioxated.]

*Gases* (Number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 360.1; carbon dioxid (set free from bicarbonates on evaporating to dryness), 728.1.

| Formula and name. | Bureau of Chemistry. | Advertised. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|---|
| | *Parts per million.* | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 15.0 | 12.0 | 0.15 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 5.3 | 2.6 | .05 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 3,966.7 | 2,663.6 | 38.86 | 100 |
| $NO_3$ (nitric acid radicle) | None. | 4.0 | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | Trace. | ..... | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | .3 | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | (a) | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | ..... | 500 |
| Cl (chlorin) | 2,982.7 | 957.2 | 29.21 | 100 |
| Br (bromin) | 20.2 | 144.4 | .20 | 200 |
| I (iodin) | 1.2 | 1.7 | .01 | 500 |
| Fe (iron) | ..... | 3.7 | ..... | ..... |
| Fe, Al (iron and aluminum) | 3.7 | ..... | .04 | 500 |
| $Al_2O_3$ (alumina) | ..... | .9 | ..... | ..... |
| Mn (manganese) | ..... | 1.5 | ..... | ..... |
| Ca (calcium) | 601.4 | 305.5 | 5.89 | 500 |
| Mg (magnesium) | 217.1 | 153.1 | 2.13 | 500 |
| Ba (barium) | 1.1 | 8.7 | .01 | 2,000 |
| Sr (strontium) | None. | Trace. | ..... | 2,000 |
| K (potassium) | 197.7 | 63.7 | 1.94 | 500 |
| Na (sodium) | 2,182.0 | 977.1 | 21.37 | 500 |
| Li (lithium) | 2.8 | 2.3 | .03 | 500 |
| $NH_4$ (ammonium) | 8.9 | 1.68 | .09 | 100 |
| Oxygen to form $Fe_2O_3$ | 1.6 | ..... | .02 | ..... |
| Total | 10,207.4 | 5,304.18 | 100.00 | ..... |
| Free ammonia | 8.44 | ..... | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... | ..... |
| Nitrogen as nitrites | Trace. | ..... | ..... | ..... |

(a) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 26.54 | 0.26 |
| LiCl (lithium chlorid) | 16.8 | .16 |
| KCl (potassium chlorid) | 357.9 | 3.51 |
| NaCl (sodium chlorid) | 4,584.8 | 44.92 |
| KBr (potassium bromid) | 30.0 | .29 |
| KI (potassium iodid) | 1.6 | .02 |
| $Na_2SO_4$ (sodium sulphate) | 7.7 | .08 |
| $NaBO_2$ (sodium metaborate) | (a) | ..... |
| $NaNO_2$ (sodium nitrite) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 1,367.0 | 13.39 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 2.0 | .02 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 1,307.1 | 12.80 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 2,485.7 | 24.35 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 5.3 | .05 |
| $SiO_2$ (silica) | 15.0 | .15 |
| Total | 10,207.44 | 100.00 |

(a) Small amount.

No. 1395.—*Victoria water, Saratoga, N. Y.*

[Sodic, muriated, saline (bromic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 160.6; carbon dioxid (set free from bicarbonates on evaporating to dryness), 67.8.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 14.8 | 0.56 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 27.1 | 1.02 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 365.2 | 13.71 | 100 |
| $NO_3$ (nitric acid radicle) | None. | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | Trace. | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 1,238.8 | 46.51 | 100 |
| Br (bromin) | 20.2 | .76 | 200 |
| I (iodin) | Trace. | ..... | 500 |
| Fe, Al (iron and aluminum) | 4.2 | .16 | 500 |
| Ca (ealcium) | 8.9 | .33 | 500 |
| Mg (magnesium) | 21.6 | .81 | 500 |
| Ba (barium) | None. | ..... | 2,000 |
| Sr (strontium) | None. | ..... | 2,000 |
| K (potassium) | 140.4 | 5.27 | 500 |
| Na (sodium) | 822.0 | 30.86 | 500 |
| Li (lithium) | .25 | .01 | 500 |
| $NH_4$ (ammonium) | .05 | ..... | 500 |
| Total | 2,663.5 | 100.00 | ..... |
| Free ammonia | .05 | ..... | ..... |
| Albuminoid ammonia | .02 | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... |

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 0.15 | ..... |
| LiCl (lithium chlorid) | 1.5 | 0.06 |
| KCl (potassium chlorid) | 249.3 | 9.36 |
| NaCl (sodium chlorid) | 1,844.5 | 69.24 |
| KBr (potassium bromid) | 30.0 | 1.13 |
| KI (potassium iodid) | Trace. | ..... |
| $Na_2SO_4$ (sodium sulphate) | 40.1 | 1.51 |
| $NaBO_2$ (sodium metaborate) | Trace. | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 303.8 | 11.41 |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 130.0 | 4.88 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 36.0 | 1.35 |
| $Fe(HCO_3)_2$ (ferrous bicarbonate) | 13.3 | .50 |
| $SiO_2$ (silica) | 14.8 | .56 |
| Total | 2,663.45 | 100.00 |

No. 1396.—*Carlsbad water, Saratoga, N. Y.*

[Sodic and calcic, muriated, alkaline, saline, (ferruginous, lithic, bromic, iodic), carbondioxated.]

*Gases* (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm pressure).—Carbon dioxid (free), 426.0; carbon dioxid (set free from bicarbonates on evaporating to dryness), 779.0.

| Formula and name. | Bureau of Chemistry. | Total inorganic material in solution. | Amount of water used for each determination. |
|---|---|---|---|
| | *Parts per million.* | *Per cent.* | *Grams.* |
| $SiO_2$ (silica) | 13.5 | 0.10 | 2,000 |
| $SO_4$ (sulphuric acid radicle) | 2.8 | .02 | 500 |
| $HCO_3$ (bicarbonic acid radicle) | 4,244.5 | 32.78 | 100 |
| $NO_3$ (nitric acid radicle) | None. | ..... | 100 |
| $NO_2$ (nitrous acid radicle) | None. | ..... | 100 |
| $PO_4$ (phosphoric acid radicle) | None. | ..... | 500 |
| $BO_2$ (metaboric acid radicle) | (a) | ..... | 500 |
| $AsO_4$ (arsenic acid radicle) | None. | ..... | 500 |
| Cl (chlorin) | 4,419.6 | 34.14 | 100 |
| Br (bromin) | 40.3 | .31 | 1,000 |
| I (iodin) | 1.6 | .01 | 500 |
| Fe, Al (iron and aluminum) | 13.1 | .10 | 500 |
| Ca (calcium) | 628.6 | 4.85 | 100 |
| Mg (magnesium) | 298.8 | 2.31 | 100 |
| Ba (barium) | 10.1 | .08 | 2,000 |
| Sr (strontium) | Trace. | ..... | 2,000 |
| K (potassium) | 237.8 | 1.84 | 500 |
| Na (sodium) | 3,014.5 | 23.28 | 500 |
| Li (lithium) | 5.3 | .04 | 500 |
| $NH_4$ (ammonium) | 13.4 | .10 | 100 |
| Oxygen to form $Fe_2O_3$ | 5.7 | .04 | ..... |
| Total | 12,949.6 | 100.00 | ..... |
| Free ammonia | 12.62 | ..... | ..... |
| Albuminoid ammonia | None. | ..... | ..... |
| Nitrogen as nitrates | None. | ..... | ..... |
| Nitrogen as nitrites | None. | ..... | ..... |

(a) Small amount.

HYPOTHETICAL FORM OF COMBINATION.

| Formula and name. | Parts per million. | Per cent of total inorganic material in solution. |
|---|---|---|
| $NH_4Cl$ (ammonium chlorid) | 39.67 | 0.31 |
| LiCl (lithium chlorid) | 31.8 | .25 |
| KCl (potassium chloride) | 415.6 | 3.21 |
| NaCl (sodium chlorid) | 6,873.5 | 53.07 |
| KBr (potassium bromid) | 60.0 | .46 |
| KI (potassium iodid) | 2.1 | .02 |
| $Na_2SO_4$ (sodium sulphate) | 4.1 | .03 |
| $NaBO_2$ (sodium meta borate) | (a) | ..... |
| $Na(HCO_3)$ (sodium bicarbonate) | 1,126.7 | 8.70 |
| $Ba(HCO_3)_2$ (barium bicarbonate) | 19.1 | .15 |
| $Sr(HCO_3)_2$ (strontium bicarbonate) | Trace. | ..... |
| $Mg(HCO_3)_2$ (magnesium bicarbonate) | 1,798.9 | 13.89 |
| $Ca(HCO_3)_2$ (calcium bicarbonate) | 2,545.8 | 19.66 |
| $Fe_2O_3$, $Al_2O_3$ (ferric oxid and alumina) | 18.8 | .15 |
| $SiO_2$ (silica) | 13.5 | .10 |
| Total | 12,949.57 | 100.00 |

(a) Small amount.

## DISCUSSION OF ANALYSES.

Only a few general comments are necessary in regard to this group of waters. First, it will be noted that an examination was made of samples of Vichy and Hathorn obtained both at the spring and on the open market. In all likelihood these samples were taken from the spring within the same year, and yet the analyses differ considerably, showing that the composition of the various waters varies materially from time to time. Some of the probable reasons for such variation are pointed out by the following letter from the owner of the Arondack spring:

> We have here wells varying in depth from 150 feet to 600 feet. In drilling the well the veins of water are liable to be struck at many intervals from 40 feet down to the bottom. The well is tubed, generally with a small iron pipe, down to a point that may be decided on as securing the best water. At the bottom of the pipe a seed bag is attached, which very quickly swells up and for a time, if properly adjusted, will shut out all the water above it, so that the yield is only of the water entering below the seed bag. Now in the course of time, which may be a few months and may be two years, the seed bag frequently shrinks or is eaten away a little, and this would allow a certain amount of the upper water to enter. It is also my experience that within about two years there will be at some point of the pipe perforations which again would allow water to enter.
>
> Another point which we have noted is that many of the Saratoga springs are connected with each other. I do not know whether pumping is carried on at all by the mineral-water companies, but it is by all the gas companies here, involving a matter of about 50 wells. We have at our gas works two wells which are connected with a well of a competitor. When he pumps very hard or at all our water levels are more or less affected, as is also our yield of gas. He can pull our level down more than 20 feet. It seems to me that such a condition would, through hydrostatic pressure, affect the amount of water running into the well from the various veins.

Another point well worthy of note is the fact that practically all of these springs have a much smaller mineral content than they had about thirty-five years ago, when Prof. C. F. Chandler made an examination of most of the springs then in existence. By comparing the results here reported with those obtained by Professor Chandler[a] it will be noted that nearly all of the springs now contain only from one-half to one-fifth as much mineral matter as they did in about 1871. The natural inference would be that the springs were gradually dying out were it not for the fact that many new wells have been driven since the analyses were made in 1871, so that a much larger volume of water is now taken from the strata feeding the Saratoga springs than was formerly taken. It is therefore impossible to say whether the springs are gradually dying out or whether they are weaker in mineral content because of the greatly increased amount of water that is with-

[a] Cairns, Quantitative Analysis, p. 194, or American Chemist, December, 1871.

drawn. It is, of course, probable that some of this difference is due to natural variation in the water from time to time, but it is hardly possible that such a difference as appears is entirely due to such periodic fluctuations.

A rather curious case is presented in the Chief water, the advertised analysis of which, made some years ago, shows only about half as much mineral matter as the analysis made recently by the Bureau of Chemistry.

To summarize the results in a few words, it will be noted that the following points have been brought out by the study of Saratoga waters:

(1) The waters are in nearly all cases markedly weaker in mineral content than they were about thirty-five years ago.

(2) There is a great variation in the total mineral content of individual springs from time to time.

(3) The rarer elements, such as lithium and bromin, seem to vary to a greater extent than the other elements present.

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